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STATUS AND TENDENCIES OF GEOGRAPHY IN CANADA[1]

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President of the Association, 1952-53

Geographic activity in Canada occupies three distinct fields - teaching, professional organization, and production. In each of these fields it manifests different characteristics which I shall try to point out.

TEACHING

Twenty years ago there was no department of geography in Canada. The first, at the University of Toronto, did not begin to accept candidates for the honours B.A. and for the Masters degree until 1940. The others were established during, and especially after, World War II. This means that we are still very close to the beginning and that there remains a great deal of passive resistance to be overcome. It also means that geography in Canada is more or less marked by the intellectual or academic influences which many Canadian leaders brought back from the foreign schools in which they were trained. It is easy to detect the imprint of the English school, the University of London in particular; the imprint of the American school, especially of Syracuse and Clark Universities; and that of the French school, mainly of Paris and Grenoble Universities.

To these external influences must be added individual influences and the efforts to adapt to the particular needs of the Canadian environment. As a result of all these forces, the teaching traditions have not yet had time enough to sink their roots very deeply into our cultural soil; they lack homogeneity. Yet the diversity of forces which inspire our discipline is none less full of promise and there is no doubt that in time the exterior influences added to those of our particular milieu and individuality will end by joining, and that from it will emerge a true Canadian school of geography, autonomous and original. This Canadian school of geography is actually in a state of gestation. Those responsible for the trends given to the teaching of geography are relatively young, many of them less than 40 years of age. Consequently they have not yet produced the imposing works which characterize outstanding heads in other countries. They have not had the advantage of building on the work accomplished or developed by a preceding generation. With the proselyting enthusiasm of the young, they spend a great deal of their energy in combating prejudices, in overcoming material difficulties, and in forming followers who will assure the continuance of the geographic discipline. At the same time they are often forced to sacrifice the personal satisfaction and fame that only research can bring to men of science. Thus it is often a thankless task which one should not underestimate. But the true work of our departments of geography will be measured by the teams of geographers produced, the teams who will build the science of geography in Canada.

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[1] Presidential address, delivered at the Third Annual Meeting of the Canadian Association of Geographers, London, Ont., 1953.

It is quite easy to get a fair idea of the nature and value of geography teaching in Canada. I do not know any other discipline which has produced more reports and conducted more investigations in the course of the last few years.[1] Canadian geographers are thus showing their need for taking stock of their position, so that they might establish it on a solid and permanent basis.

In the provinces of Canada there exist eight University Institutes, Departments or Divisions where, in addition to general cultural courses, a rather complete cycle of specialized studies in geography, directed toward research and professional training, is given. Ontario has three of the geographic centres, those at the University of Toronto, McMaster University (Hamilton) and the University of Western Ontario (London). In Quebec there are also three: at Université Laval (Quebec City) and at McGill University and the Université de Montréal, both in Montreal. In Western Canada, the University of British Columbia (Vancouver) has also a well established division of geography within the Department of Geology and Geography, and in the Prairie Provinces, there is a Department of Geography at the University of Manitoba, in Winnipeg. Lectureships or professorships in geography also exist at a goodly number of other universities, for example: at the University of Alberta (Edmonton), at the University of Ottawa, at Queen's University (Kingston), at Carleton College (Ottawa), at United College (Winnipeg), at Memorial University of Newfoundland (St. John's) and in the Canadian military colleges.

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[1] Taylor, G.T. Geography at the University of Toronto, Can. Geog. Jour., 23, 1941, p. 152-154.

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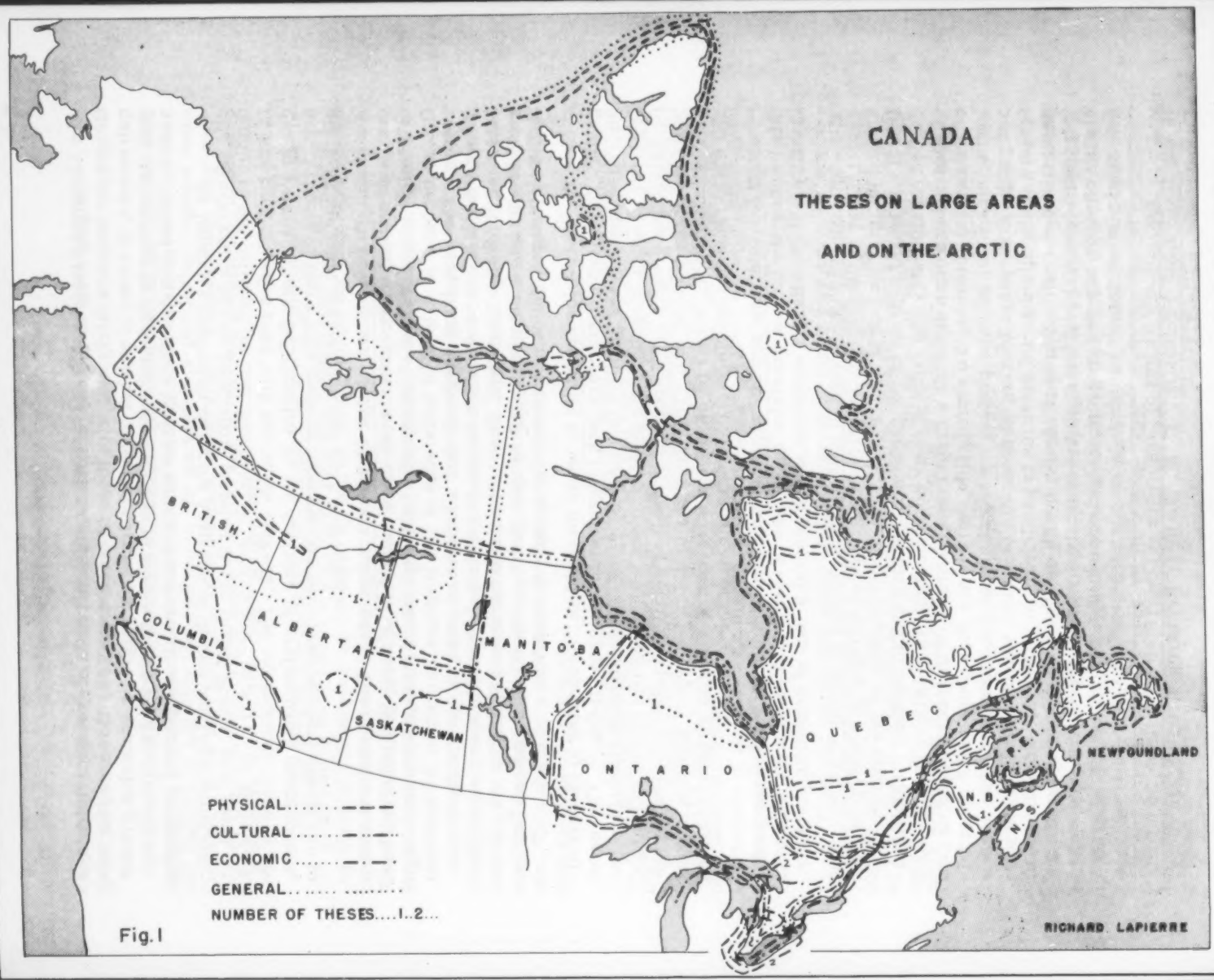
CANADA
THESES ON LARGE AREAS
AND ON THE ARCTIC
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
N.B.
N.S.
P.E.I.
NEWFOUNDLAND
PHYSICAL
CULTURAL
ECONOMIC
GENERAL
NUMBER OF THESES....1..2...
RICHARD LAPIERRE

Fig. I

Judging from university calendars, the curricula of our Departments of Geography compare fairly well with those in other countries. However, our requirements, in terms of number of hours of lectures, might be somewhat greater than the average in European universities. In comparison with American standards, we also appear to place greater stress on the practical aspects of geography.

An inquiry,[1] conducted under the auspices of the National Research Council, several years ago on geographic training in the United States, paid much attention to the deficiencies that handicapped geographers to carry on their work in war time or peace time with maximum success. The suggestions made in order to remedy these deficiencies in the training of professional geographers, are, I think, of more than passing interest for us. That is why I should like to point out the main suggestions that have been made.

1. To develop knowledge of foreign languages. The committee stated that professional geographers were often incapable of using published sources in foreign languages and of conducting investigations or interviews in foreign fields, because of a lack of knowledge of the language spoken in the surveyed region. The committee suggests that advanced courses in geography should, through the medium of research seminars, train the student in using information published in foreign languages. They believe that the responsibility for this initiative should not be completely placed upon the departments of languages, but that they devolve upon the departments of geography themselves.

2. To develop an ability to sense the problem. According to the investigators, American geographers lack judgement in numerous fields.[2] The report underlines notably the inability to sense the scope of problems, to formulate objectives, to adapt oneself to the level of those with whom one comes in contact, to discriminate which are important or useless details, to judge the relative importance of phenomena, etc. This remark, to which the report attaches a great deal of importance, seems to be a plea in favour of a broad general education and the harmonious development of the faculties of the student.

3. To develop scientific precision. The committee pointed out under this heading the lack of precision in the use of terms and measures, a definite inability in the handling of statistics, and in general a lack of scientific precision.

4. To develop training in allied fields, notably in social sciences. The report stresses the fact that American geographers working in Washington often showed an ignorance or at best a superficial understanding of the economic, political and social aspects of the problems that they had to consider. This handicapped considerably the value of their contribution. They believe that the work of geographers often demands a deeper understanding of the social sciences than of the natural sciences. To remedy this deficiency they propose the three following means: a) to have professors of collateral departments revise theses and geographic essays bearing on economic or human aspects; b) to invite professors of the allied social sciences to participate in geographic seminars; c) to undertake cooperative works of research with members of departments who are interested in social problems; d) to encourage by every possible means an exchange of views between geographers and economists, historians, etc. "Perhaps the single most important need in our professional training is training in

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[1] Preliminary Report of Conference of Committee on Training Standards in the Geographic Profession, U.S. National Research Council, Hershey, Pennsylvania, p. 1-17.

[2] This is a rather serious deficiency indeed which surpasses professional training and involves the whole process of education.

cooperative research", says the report. To provide for such training would require major changes in graduate work.

5. To set the stress on the teaching of systematic geography rather than on regional geography. It was emphasized that the candidates who had the greatest facility in adapting themselves to the surveying of particular regions were those who were best prepared in systematic geography. Consequently they suggested the reduction of the number of courses in regional geography, to develop a greater facility in systematic geography.

6. To develop the technique of interpreting aerial photographs. American geographers have shown a particular aptitude in understanding and interpreting physical phenomena as revealed by aerial photographs, but they have shown themselves less facile in the understanding of human and economic phenomena. The Committee believes that it is the duty of departments of geography to obtain the necessary equipment to develop this technique and this aptitude.

(Sooner or later, and particularly Canada where good accurate topographical maps are often lacking, training in the interpretation of aerial photographs and also the building up of departmental air photo libraries, should, it seems to me, call for as much attention as map interpretation exercises and map libraries. This might be a profitable project to initiate or to develop in many Canadian departments of geography.)

7. Cartographic training. The report seems to give minor importance to the mathematical aspects of cartography, and even to the construction of cartographic projections. On the other hand, they attach much greater significance and they underline the frequent short-comings in geographers in the following fields: a) a facility in presenting reports in the form of maps indicating relation of causes to effects; b) a definite idea of the requirements, the possibilities and limitations of the map as a means of expressing geographic facts; c) principles of design and presentation; d) familiarity with simple mathematical and statistical techniques and tools.

It seems to me that some of these remarks might profitably be applied to Canadian geography centres and that therefore they could not leave us completely unconcerned. For while Canadian universities seek their proper paths at the price of an intense and promising activity, they are placing in the field an increasing number of geographers who are bringing about the organization of their profession across the length and breadth of the country.

PROFESSIONAL ORGANIZATION

The proceedings of the third annual Meeting of our Association reveal the seriousness and the enthusiasm which geographers in Canada are bringing to the task of grouping themselves in a common cause with the objective of encouraging the growth of their discipline, as much in the scientific field as in the professional. Our Association is not content with a mere theoretical existence. Its counts already more than one hundred full members, and the number of geographers who are eligible for membership is growing rapidly each year.

Thanks to membership fees and to the generous cooperation of the Geographical Branch of the Department of Mines and Technical Surveys, the Association published two issues of The Canadian Geographer, and a News Bulletin during the year. Two issues of Geographical Bulletin, a Revue Canadienne de Géographie, a Cahier de Géographie and a map of Canada were also distributed to members. The Association was represented by Dr. Putnam at a special Federal Government Committee for the study of the 1:50,000 Canadian map series. Delegates attended the Seventeenth Congress of the International Geographical Union and the Third Consultation of the Pan-American Institute of Geography which were both held in Washington last summer. In connection with the Royal Commission on National Development in the Arts, Letters and Sciences, our Association promoted the idea of setting up scholarships and grants in geography; it called to the attention of military authorities the need for more developed geography training in Canadian Military Colleges, and helped to revive the Canadian Committee of the International Geographical Union. Our Association has thus demonstrated its desire for action and the sound basis of its organization.

Within the National Association, a regional group of geographers has come into being - the Southern Ontario Division - which met several times in the course of the past year. It is of more than passing interest to point out that the Ontario Education Association has a geographic section which has succeeded in having the study of geography admitted to the curriculum in all classes up to Senior Matriculation in the Province of Ontario. This is indeed a momentus step.

In addition to these Associations, which are fundamentally professional, there exist a goodly number of geographical societies whose main activities are publication of magazines, organization of public lectures and of geographic excursions. Thus, there is the Canadian Geographical Society of Ottawa, the two geographical societies of Montreal and the geographic society of Quebec.

Among the major outlets available to Canadian geographers, I must mention first of all the Governments, both Federal and Provincial. The most important is evidently the Geographic Branch of the Department of Mines and Technical Surveys at Ottawa. This Branch provides full-time employment for twenty geographers, as well as employment for a number of other clerical and technical workers. These figures do not include the numerous professors and students who work for the Branch during the summer.

The Federal Government also uses some six or seven geographers in the Joint Intelligence Bureau of the Department of National Defence.

It is interesting to note that the example of the Federal Government in these fields is beginning to be imitated by Provincial and Municipal Governments. Thus, a geographic division was recently established by the Department of Lands and Forests at Victoria, B.C. This new division already employs two full-time geographers and it is quite likely that its field of action will be enlarged in the near future. A similar organization was created some months ago by the Department of Industry and Commerce of the Province of Quebec. This geographic service, in addition to two-full time geographers, employs several professors and students in geography for its summer work. Several other departments of Provincial Governments, although not having specific geographic divisions, employ geographers both on a full-time and on a part-time basis. For example, the

Lower Fraser Valley Conservation Board in British Columbia; the Town and Rural Planning Branch of the Department of Municipal Affairs of Alberta; the Department of Natural Resources of Saskatchewan; the Department of Planning and Development of Ontario, and the Department of Lands and Forests and of Colonization of Quebec. In some of the above cases geographers are in charge of operations.

It is evident from the above that the geographer, a newcomer to the field of professional occupation, is proving that he can make a definite contribution to modern society in fields other than teaching. He is bringing a new set of qualifications and a new scale of salaries to the Civil Services of our country. One can then conclude that the profession of geographer is now well established and that with the drive which marks its representatives it will develop in such a way as to be both recognized and accepted by all.

Many geographers, whether in government or in teaching, are engaged in scientific research. This brings us to our third and last point.

RESEARCH

In order to get a picture of what has been done and what remains to be done in this respect, I shall first of all refer to a statistical inventory. It will then be easier for us to perceive the main tendencies of our research, to evaluate the task which it faces and to discuss the possible ways of expanding it.

The statistical analysis of our achievements has been made possible, thanks to an interesting analysis by Dr. Andrew H. Clark, published in the Geographical Review,[1] and to the Bibliographical Series compiled by the Geographical Branch, Department of Mines and Technical Surveys, Ottawa.[2]

University Theses and Essays

Table I reveals some statistical information on the dissertations accepted by Departments of Geography of Canadian universities since their formation, in fulfilment of the requirements for the degrees of B.A., B.Sc., M.A., M.Sc. and Ph.D. It includes also, several theses bearing on Canadian subjects but prepared in American universities.[3] With rare exceptions,[4] these works date from 1941. These figures do not include, however, numerous theses of geographical interest which have been presented in Schools of Commerce or in Departments of Economics, History, Geology, Political and Social Sciences.

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1 Clark, Andrew H. Contributions to Geographical Knowledge of Canada since 1945, Geog. Rev., XL, 1950, p. 285-312.

2 Bibliographical Series, Geographical Branch, Dept. of Mines and Tech. Surveys, Ottawa, 1950-1953.

3 Notably at Syracuse and Clark Universities.

4 Some of these exceptions are, for example, theses concerned with the teaching of geography for the degree of Doctor of Pedagogy.

TABLE I

Geographic Studies (University Theses and Essays) in Canada

REGIONAL	Number	% of TOTAL
General (Global)	62	34
Economic	48	27
Human and Cultural	35	19
Physical	22	12
Total Regional	167	92
GENERAL-SYSTEMATIC		
Physical	1	1
Economic	1	1
Cartographic	1	1
Human and Cultural	0	0
Nature of Geography	6	3
Historical Geography	5	2
Total General-Systematic	14	8
TOTAL	181	100

181 dissertations have been accepted - an imposing total when one recalls the brief history of our departments of geography. It is true that of this total 75 were for the B.A. or B.Sc. which, naturally, does not always imply original research. There remain, however, more than a hundred studies for the Master's degree or the Doctorate. This is a quite satisfactory balance.

The table reveals that most of these theses bear on studies of regional geography and that very few are concerned with problems of systematic geography. Actually, 167 dissertations (92% of the theses presented) are concerned with regional geography. This seems normal enough to me. One cannot expect members of young departments to tackle subjects of fundamental research. Among these, global studies prevail. Thus, 62 papers (34% of the total) deal with regions in all their aspects. Next come economic studies of which there are 48, (27% of the total); then cultural monographs, 35 studies (19% of the total), and finally, physical studies, 22 papers (12% of the total).

Of the total number there are only 14 dissertations (8% of the total) which treat of non-regional subjects. Of this number one was devoted to physical geography, one to economic geography and one to cartography. Problems of human geography, not applied to particular regions, have been completely ignored. Essays on the nature of geography have, on the other hand, provided six papers. Finally, five theses were devoted to subjects of historical geography.

Regions Surveyed

Let us now examine what parts of the country have been studied in this academic field. This might be of some help in the planning of future surveys.

Theses on large areas.

Figure 1 shows the extent and the main topic of the theses written on large areas. There are five theses not shown on this map, dealing with Canada as a whole. These are not of an equal value since two were presented for the B.A., one for the M.A., and two for the Ph.D. They include studies on climate, on the lumbering industry, on the distribution of French-Canadian population, on fresh-water fisheries and on national and international boundaries.

We see that Newfoundland, for instance, has inspired four dissertations concerned with the whole of the province. One of these dissertations is global, one economic, one cultural and one physical. Three master's theses and the doctoral dissertation have been devoted to this area. Prince Edward Island has been studied in a global survey in one essay for the B.A., and there is a master's thesis on land utilization. New Brunswick has attracted only one piece of research - a master's thesis on the economic aspects of paper industry. Nova Scotia is less fortunate since it has inspired no theses at all.

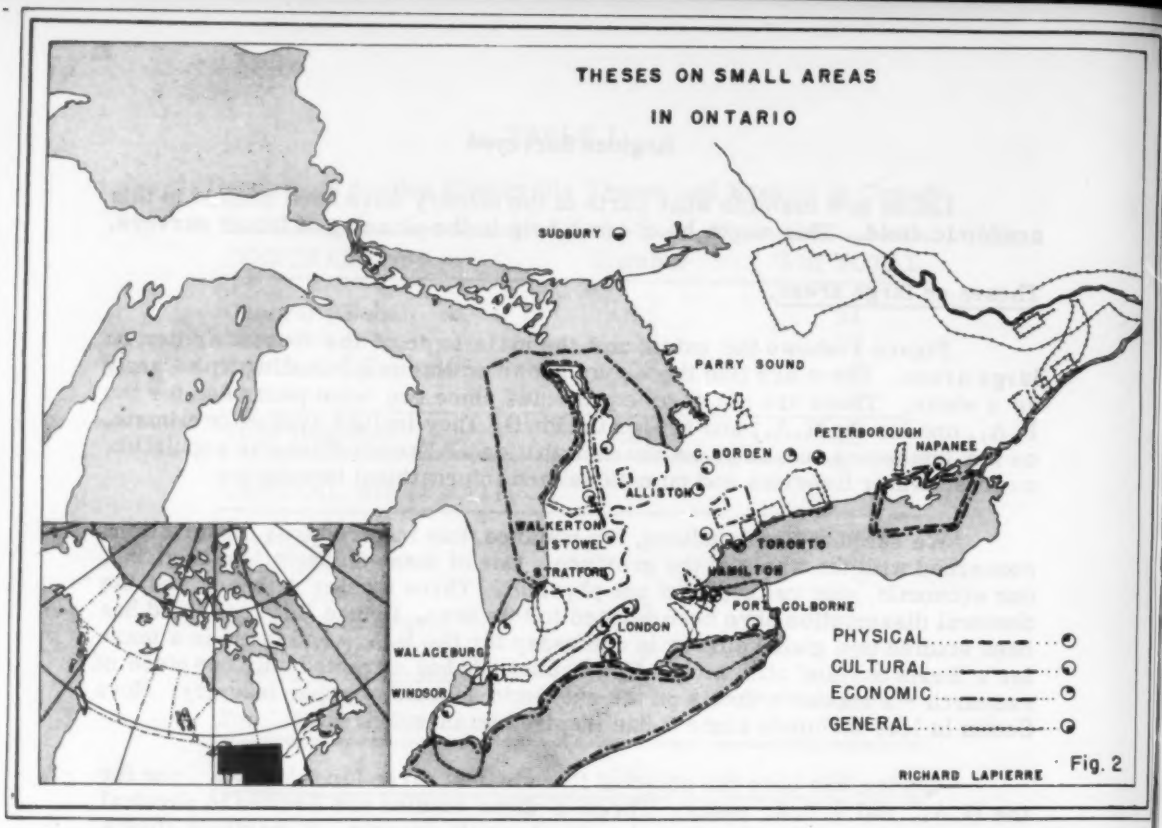
Quebec has been the object of five studies, three for the Ph.D., one for the M.A., and a B.A. essay. Three of these studies are devoted to physical aspects, one to cultural and another to economic aspects. A master's thesis has been written on the ice conditions in the Gulf of St. Lawrence.

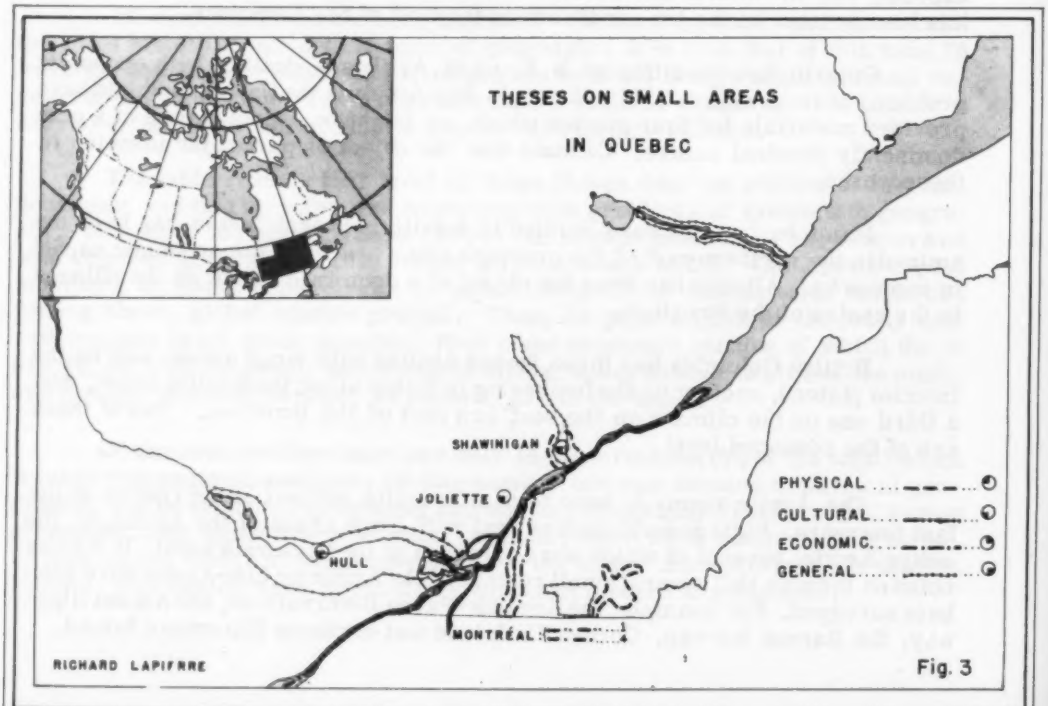
Ontario has ten different B.A. or M.A. theses dealing with economic problems of large regions. The Hudson's Bay area and the Canadian Shield have provided materials for four studies which, as might be expected, are of a predominantly physical nature. Climate was the object of particular attention in these works.

Manitoba has not been studied in totality. Saskatchewan has been examined in the northern part of the province alone and from the economic aspect in two works. Alberta has been the object of a doctorate thesis on the villages in the centre of the Province.

British Columbia has three theses dealing with large areas: one on the interior plateau, another on the lumbering industry along the Pacific coast, and a third one on the climate on the southern part of the Province. Two of these are of the advanced level.

The Arctic seems to have been a favourite subject in the course of the last few years. Eight general studies deal with large areas of the Arctic, or the entire Arctic, several of which were prepared at the Doctorate level. It may be noted on the map that several small regions of the Arctic or Sub-Arctic have also been surveyed. For example, the Kogaluk-Payne River valleys, the Alaska Highway, the Barnes ice-cap, Cornwallis Island and northern Ellesmere Island.


THESES ON SMALL AREAS
IN ONTARIO
SUDBURY
PARRY SOUND
PETERBOROUGH
NAPANEE
C. BORDEN
ALLISTON
WALKERTON
LISTOWEL
STRATFORD
TORONTO
HAMILTON
PORT COLBORNE
LONDON
WALACEBURG
WINDSOR
PHYSICAL
CULTURAL
ECONOMIC
GENERAL
RICHARD LAPIERRE
Fig. 2


THESES ON SMALL AREAS
IN QUEBEC
SHAWINIGAN
JOLIETTE
HULL
MONTRÉAL
PHYSICAL
CULTURAL
ECONOMIC
GENERAL
RICHARD LAPIERRE
Fig. 3

Theses on small areas.

Let us now examine the more detailed surveys applied to small areas or localities. Some provinces can be taken care of rapidly. Thus, for example, Newfoundland, and its single master's thesis devoted to St. John's. There is no detailed regional survey of Prince Edward Island. Nova Scotia has but two: one on land utilization in Antigonish County and another on the steel industry in Sydney. New Brunswick is also rapidly dealt with since it comprises but a single work on the glacial morphology of the St. John River Valley. This is a doctoral thesis.

In Quebec the pattern is a little more complicated. Here we find twenty titles, most of which are for the M.A. and the Ph.D. Of these, four are regional monographs, two or three devoted to physical aspects, six to economic aspects and seven to problems of cultural or human geography. The most heavily populated portion of the province, the valley of the St. Lawrence and its main tributaries, has evidently been the object of greatest attention.

Southern Ontario presents a more elaborate pattern than any other part of Canada. There are some 75 studies in all: 51 B.A. surveys, 23 M.A. and M.Sc. theses and four doctoral works including the Niagara Peninsula, the Grand River Valley, and Essex County.

We note four studies concerning Manitoba: a doctoral thesis on the Red River Valley, two studies on the economic problems of the Winnipeg agglomeration and a B.A. essay on Churchill. Saskatchewan and Alberta are covered by a master's thesis on the cultural geography of Lesser Slave Lake.

British Columbia counts 15 regional titles, most of which are master's theses. Vancouver and New Westminster have been the most popular choices, as one might expect. But several other regions have attracted researchers. Thus, there is a survey on Queen Charlotte Islands, another on Prince Rupert, one on Okanagan Valley, a study on Kootenay, an appreciation of the Canadian-American boundary, and several others.

This inventory leads to the following conclusions: 1) that our universities have made fairly important contributions to present geographic knowledge of our country; 2) that systematic geography not applied to regions has, as yet, had little appeal to Canadian geographers; 3) that the greater part of these dissertations are concerned with global regional geography; 4) that certain regions in the southern parts of Ontario, Quebec and British Columbia have attracted a considerable number of surveys while many other regions have been left untouched; 5) that there is no evidence of definite long-term projects or programmes of research on national, provincial or even departmental bases. In most cases, I gather, the candidates for a degree themselves choose their own subject according to their own centre of interest. This is often the price of the candidate's enthusiasm and success in his enterprise.

Periodical Literature

Table II gives a statistical picture of periodical literature on the geography of Canada in the years 1940-1950.[1]

TABLE II

Geographical Periodical Literature in Canada, 1940-1950

REGIONAL	Number	% of TOTAL
General	49	4
Economic	347	27
Human	108	8
Physical	381	29
Cartographical	6	1
Total Regional	891	69
GENERAL-SYSTEMATIC		
Physical	52	4
Economic	191	15
Cartographic	25	2
Human and Cultural	87	7
Nature of Geography	9	1
Historical Geography	8	1
Total General-Systematic	386	31
TOTAL	1,328	100

Of a total of 1,328 articles published in the principal Canadian periodicals, it is apparent that regional studies are in the majority, but to a lesser degree than for university theses and essays (69% in place of 92%). Physical geography heading the list, is followed closely by economic and human emphasis. It must be remarked, however, that the majority of these articles have been written by non-geographers and published in periodicals not specialized in geography.

Here we come to one of the great weaknesses of our scientific structure: a lack of specialized periodicals for geographical research. But I would not like to underestimate what is being done at this time. The Canadian Geographical Journal is a remarkable magazine which often publishes articles of great interest. This journal certainly deserves special mention among Canadian periodicals for its high literary and typographical standards. Even if this magazine

[1] After Bibliography of Periodical Literature on Canadian Geography for the Period 1940-1950, Bibliographical Series, No. 9, Geographical Branch, Dept. of Mines and Tech. Surveys, Ottawa, 1950.

could, without changing its character, accept articles on pure research, it would still be insufficient in view of the increasing amount of research carried out in this country. The prospect of publication has always been a powerful stimulus for researchers. It is often the only material satisfaction that they reap from their labour.

I am pleased to note that the Revue Canadienne de Géographie is becoming more regular and more frequent. There have been three issues during the last six months. I may say that it is now established on more solid basis and that it will soon be in a position to meet at least the needs of a small group of geographers.

Some departments have attempted to remedy the penury of scientific periodicals by occasional publications. Thus Université Laval has its own Cahiers de Géographie; the University of Toronto, the mimeographed Shield, and the University of Western Ontario, the mimeographed Ontario Geography Monographs.

The Canadian Geographer is the latest of our periodicals. The two first issues, which appeared in the course of the present year, are completely devoted to the papers presented at the annual meetings. It is possible that this journal will enlarge its pages in order to publish one or more supplementary issues each year.

Those are our specialized periodicals. They are clearly insufficient. It is to be hoped that the future will bring a development in the form of regional journals which would contribute largely to the spread of our discipline.

Books

The list of books on Canadian geography, is hardly as long as the one on periodicals. Dr. Clark, a native Canadian geographer, has attempted to list them.[1] They add up to a total of 30 volumes. The large majority of these books have been written by non-professional geographers. Historians, economists, or sociologists are responsible for the great majority of them. I admit, that Dr. Clark's inventory is not complete and that it has several important omissions. I believe, however, that his inventory could be brought up to date by adding about a dozen titles.

I would not like to bring to a close these observations without making a special mention of the contributions made by the Geographical Branch, in Ottawa. I have already mentioned the Bibliographical Series, but, I would also like to recall the Miscellaneous Papers, the Geographical Bulletins, the Foreign Geography Information Series, and the Canadian Geography Information Series. In addition, the Geographical Branch sponsors a number of research projects which have not yet reached the publication stage.[2]

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[1] Clark. Op. cit.

[2] Since this article was written the first of a Memoir series has appeared. (Ed.)

Research Programmes

The Geographical Branch programme of research encompasses a vast field of action, partly born to fill in the gaps left by university regional studies. A good deal of attention is given to the Arctic where several parties each summer carry out detailed surveys of small areas - a controlled sampling designed to provide data on characteristics of more extended territories. These studies place particular emphasis on the interpretation of aerial photographs. They include observations on ice and frost conditions on drainage patterns, on vegetation, on physiography and permafrost. Much attention is also devoted to the southeastern part of the country, and in particular to regions which had been neglected until quite recently, such as Newfoundland, the Maritime Provinces, and the Prairie Provinces. In addition, work has been carried out in British Columbia, in Ontario, and in Quebec. In cooperation with the Civil Defence program, the Geographical Branch has undertaken urban studies in a large number of cities, Finally, the Branch has assumed some responsibility in the preparation of a new and up-to-date Atlas of Canada.

The majority of Canadian geographic centres are busy on more or less elaborate programs of research. McGill devotes special attention to glaciology and climatology which has not prevented the department from taking part in an interesting project in the Richelieu River valley under the auspices of the Central Mortgage and Housing Corporation. Laval is also actively engaged in research ranging over a variety of regional surveys. Our Vancouver colleagues are spreading their energy over several fields of research: physiography of Arctic areas, cartographic techniques, and applied climatology. McMaster is concentrating on the Niagara Peninsula, on Wentworth County and on the city of Hamilton. The University of Western Ontario is particularly devoted to urban geography and the 14 counties which, by its charter, it is committed to serve. Toronto has already shown emphasis in several fields, particularly on the physiography of large regions of Southern Ontario. Finally, the University of Montreal is busily engaged on the problem of terraces, on the geographical aspects of modern aviation and on regional surveys.

CONCLUSION

It is useless to say that in spite of all these enterprises, much remains to be done. It has now become trite to say that Canada is an immense and young country, that a large part of its surface has hardly been explored, and that it needs research in all branches of natural sciences. True, few regions, even in the heavily populated part of the country have been comprehensively surveyed.

Some European countries have almost completed the regional survey of their territory. Very little is left for global research. Geographers therefore dig deeper and deeper into micro-geography, plunge into more and more specialized research, and develop such new approaches as dynamic geomorphology, psychological geography, medical geography, geography of religions, human ecology, etc. We have not yet arrived at that state. In most cases we are still at the exploratory stage. In the face of these new, or renewed conceptions, let us not loose sight of the essential object of our discipline and of the techniques which are truly our own.

In spite of all innovations, and certainly taking profit by them, geography remains the science of the landscape, and the Canadian landscapes have not yet been thoroughly analysed, described and explained. Despite all the uncertainities of our discipline, this point has never been disputed. All other forms of geography have been attacked with greater or lesser success. The true geographic interpretation of a region evidently does not consist of an inventory of already made observations on soil, relief, climate, vegetation, hydrography, population and human activity. One can fill hundreds of pages with such regional literature without achieving true geographic work. To meet the needs of our discipline, a true regional monograph is a creative work and therefore not an easy task.

We all know that global regional surveys are often underestimated by many natural scientists, on whom we must often depend, or by people who have not had the opportunity of taking into consideration the maturity of mind and the scientific interest they bear. Personally, I am convinced that we are making no mistake in directing our research in this field and that much fundamental work remains to be done in this field for the next generation.

I would like, however, to emphasize the point that there is increasing recognition of the value of geographic research in governmental circles and even in private enterprise. This is evident in a most concrete way by the increase in grants. This fact entails a double significance, for it reveals a tendency, still new, on the part of governments to include in the cost of public administration a larger and larger share for scientific services, while, on the other hand, this fact tends to give a special direction to university research.

It is indeed apparent that geographic research is more and more applied to problems of public interest. Geography is becoming useful to our modern society. It is also gradually being integrated into cooperative team work which often includes specialists from many other fields. Single-man enterprises are less common than they were in the past. This tendency, it seems to me, should be organized in such a way as to prevent the obliteration of the personality and contribution of individuals.

There exists a wonderful possibility in Canada for planning a long-term program on a national or simply regional basis where each geographic centre would have its own particular task without smothering individual initiative. With a little thinking, relatively little money, and some good will from the leaders in our discipline, such a plan could be organized. Is it worthwhile? This question I leave with you, as a conclusion to this report on geographical activity in Canada.

INTERPRETATION OF LANDFORMS FROM AIR PHOTOGRAPHS

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This paper was not available in full at the time of publication.

ABSTRACT

In spite of the use to which aerial photographs have been put in southern Ontario, there has not yet been developed a complete key for the interpretation of landforms. Accordingly, a beginning has been made on this work by the authors as a project in the Department of Geography in the University of Toronto. Certain landforms such as river valleys and escarpments are easily interpreted, but most of the forms of the glaciated landscape are not easily identified. The factors which are used in identifying lands are shape, tone, texture and shadow. Man-made patterns often provide a clue to the nature of the landform. Such a key cannot be developed without personal experience in the reading of the photographs on the ground in the exact area in which the interpretation was made. It is from the personal experience of the authors in different areas of southern Ontario that this key has been prepared.

GLACIAL, FLUVIO-GLACIAL AND FLUVIAL RELIEF OF THE NORTH-CENTRAL PART OF THE EUROPEAN PLAIN

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McGill University

Morainic deposits unevenly cover large parts of the European plain. Towards the south the drift thins out and pre-quaternary rocks appear on the surface. In the north the thick cover of morainic material fills hollows (e.g., between Warsaw and the Baltic Sea) up to 600 feet deep. In other places, however, the pre-glacial relief is reflected by today's topography. (e.g., in Pomerania and in Lithuania.)

The pattern of morainic relief is particularly clear and fresh in areas of young (Würm) glaciation in east Jutland, northeast Germany, north Poland, the Baltic countries and northwest Russia, up to the Minsk-Smolensk-Moscow-Ivanovo line. In these areas, freed from the ice-cover only some 20-40,000 years ago, there are several belts of terminal moraines with a multitude of hills and a profusion of lakes.

To the south of this area lakes of glacial origin almost disappear, morainic hills are lower and isolated, and have gentle slopes. Valleys and flat basins cover extensive areas to the south of the Würm glaciated areas. They are divided in two systems: the Western, within the North Sea Pleistocene catchment area, and the Eastern, which, during Würm times, drained to the Black Sea. The main Würm age watershed ran much to the west of today's Vistula-Dnieper dividing line, and is well marked by the critical narrow sections of the valleys of the rivers tributary to Vistula - the Bug and Wieprz.

Several stages of the gradual withdrawal of the Northern ice-cap are marked on the European plain. The state of balance, which existed when the advance of the ice-cap was checked by ice-melting at its southern border, corresponded to the immobility of the position of the border of the ice-cap and left a well known pattern of systems of hills. These terminal moraines often occur as long and high walls, often up to 300 feet relative height, and sometimes even in the shape of regular arcs. The best examples of such double morainic arcs are in Southern Finland (Salpaussalka) and in Northern Poland near Mlawa. The last stage of glaciation on the southern side of the Baltic Sea created the morainic belt of the lake-land which runs parallel to the sea coast in Germany and Poland. It is a belt, usually 10 to 25 miles wide, composed of a chaos of irregular hollows and steep hills, with many lakes and young irregular drainage. In the vicinity of the edge, the ice-cap was rich in fissures and crevasses, and eskers and drumlins were created. Sometimes the ice-cap disintegrated into isolated lobes which remained in the hollows. These basins are called by Germans "Zungenbecke" and by French "Cuvette terminale".

To the south of the terminal moraines wide flat areas of outwash plains are visible. They are connected with systems of great valleys - the "Urstrom-

"täler" of the Germans. The amount of water which originated from the melting ice-cap was enormous. It created several giant surfaces completely denuded of forms of glacial accumulation, drowned in sands or covered by marshes. These surfaces of denudation are observed in several levels, often clearly superimposed in the form of terraces.

The whole belt situated outside of the Würm - glaciated North is so rich in the flat, denuded areas, that it is often called the "Zone of Great Valleys". The only geomorphological forms which break the monotony of the scenery, are groups of parabolic sand dunes, up to 100 feet high. In many regions the flat, denuded areas seem to be composed of several parallel "Urstromtäler", which have grown together. Possibly, they resulted from several stages of "Urstromtäler", which were gradually displaced, following the retreating edge of the ice-cap. Such huge flat basins are known in Eastern Europe as "polesie's", so-called after the Polesie region in the basin of the Pripet River.

The meridian of 23° E. marks the approximate position of the young-pleistocene watershed and a geomorphological axis, dividing symmetrical systems of drainage. The Eastern basin (that of Polesie), is marshy, because of the drainage difficulties created by the uplift of the Ukrainian plate. The western basin became very well drained when, after the withdrawal of the ice-cap, the rivers found their short and direct way to the Baltic Sea. Further to the West, the "Urstromtäler" approach each other, create a kind of fan in the basin of the lower Elbe River, and form, near Berlin, the "Ländchen" scenery. This consists of several low, flat, isolated table mountains surrounded by wide and numerous valleys, which are witnesses of the powerful denudation - meagre relics of the original morainic plateau, dissected to pieces. This scenery is also known in Poland and the U.S.S.R. This two-fold division of the plain controls, to a certain extent, other phenomena, particularly the soils and the vegetation. Huge basins of outwash and the "polesie's" are often filled with deep sands which remain forested in spite of the pressure of the population.

When the rivers Oder, Vistula and Niemen found their short way to the Baltic Sea after the withdrawal of the ice-cap, they left behind a system of high terraces. They represent various stages of meanders, the Vistula being the most advanced and the Niemen, the least advanced. The east-west valleys, abandoned by the rivers in the new watersheds, still exist. Man has recreated, partly, the old hydrographic system by the network of west-east canals, which utilize the abandoned parts of pleistocene west-east "Urstromtäler".

THE DRUMLINOID LANDFORMS OF THE "BARREN GROUNDS", N.W.T.

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The term "drumlinoids" apparently originated with J.B. Tyrrell's description of the undulating, till-covered surface of the "Barren Grounds" west of Hudson Bay which he explored during the years 1893 and 1894.[1] In his report on this region, Tyrrell describes "low drumlinoid ridges of boulders", and till-covered undulating surfaces rising into "high regular drumlinoid hills", as being "common" features. Fortier also writes of the "widespread occurrences of drumlinoid topography" following flights over portions of the Barren Grounds in 1947.[2] In 1949-50, the writer made an extensive examination of the available photographs of this region, and found that drumlinoids were the most characteristic feature in the till-covered areas. On the aerial photographs, these drumlinoids appear as a "furrowed" or "corrugated" pattern covering the greater part of the surface of the Barren Grounds.

The prevalence of drumlinoids and associated glacial groovings in this region, as well as in numerous other glaciated regions in more southerly latitudes, strongly suggests that they are rather significant features of a continental glaciation.

The purpose of this paper is to draw attention to some of the more prominent characteristics of the drumlinoids, mainly as observed from aerial photographs, and to draw some tentative conclusions as to their possible modes of formation, with the hope of stimulating useful discussion.

THE FORMS OF DRUMLINOIDS

Drumlinoids are varied in form. On the aerial photographs every graduation appears, from faint, streak-like patterns to "true" Drumlins. In the main their most common form is that of a parallel series of low, spindle-shaped ridges. One of the most striking features of this pattern is its parallelism throughout any one region. In a few cases, as for example, the region in the vicinity of Dubawnt Lake, two of these parallel series of drumlinoids meet at an oblique angle.

In some places, individual drumlinoids may extend over a distance of several miles, in others they are very much shorter and resemble drumlins in form. However, between these two extremes there appears to be a great variety. Unlike the elliptical or "teardrop" plan of the drumlin, the plan of the

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1 Tyrrell, J.B. Report on the Dubawnt, Ferguson, and Kazan Rivers, Geol. Surv. Can. Ann. Rept., 9, 1906.

2 Fortier, Y.O. Flights in 1947 over the Region of the North Magnetic Pole, Paper 48-23, Geol. Surv. Can., Ottawa, 1948.

R.C.A.F. Photo

Fig.1. A striking example of drumlinoid topography, showing the characteristic pattern of these features. Photo was taken from 20,000 feet about 40 miles inland from Eskimo Point on Hudson Bay.

R.C. A.F. Photo

Fig.2. A low oblique (5000') looking Northwest across the Thelon River just west of Beverly Lake. This photo illustrates some of the various forms the drumlinoids may take. To the left of the centre of the photo there are examples of three different forms: L. to R., the very long narrow form, the more ovoid drumlin-like form, and a short spindle-shaped form.

drumlinoid has a longitudinal axis 15 to 30 times the length of the transverse axis. Some drumlinoids are tapered, others are rounded. In their longitudinal profile drumlinoids appear to have an almost horizontal surface somewhat tapered at both ends, although in many cases, a stoss and lee effect is discernible on the aerial photographs. Armstrong and Tipper state that similar drumlinoid features in north central British Columbia have, in most cases, a distinct stoss and lee.[1] They also write that "the narrower the ridge, the steeper its sides", which also seems to be the case in the Barren Grounds.

The height of the drumlinoids varies from place to place, but appears to be uniform throughout any particular "field". Tyrrell mentions a little over 125 feet as being a maximum, although Armstrong and Tipper found them to be up to 150 feet in height in British Columbia. The average is probably much lower. It should be remembered they have often been modified by solifluction, and, in many places, lacustrine or marine action. The horizontal distance between drumlinoids tends to be uniform.

The form of drumlinoids is therefore not strictly uniform, but is, rather, considerably diversified in different regions, perhaps depending to some extent on the immediate post-glacial and periglacial conditions of the particular region. The form varies from a low, pencil-like outline to something resembling the "true" drumlin in form. The "hollows" between drumlinoids may be marshy, or, in some places, they may be filled with water. Throughout the Barren Grounds, these "hollows" are often the controlling factor in the outlines of the innumerable lakes so characteristic of the region.

THE DISTRIBUTION OF THE DRUMLINOIDS

Since drumlinoids are formed of glacial materials, their distribution is obviously closely associated with the distribution of glacial drift. In the Barren Grounds, varying depths of glacial drift cover large parts of the surface. Drift areas are almost everywhere characterized by the drumlinoid landforms. Although there are often other drift features such as "dead-ice" terrain, eskers, and unmoulded ground moraine, drumlinoids are the dominant feature throughout. Similar features are mentioned in some of the literature, and may be seen on many of the aerial photographs in other regions of continental glaciation, including Baffin Island, Alaska, Labrador, as well as Central and Western Canada. Many of these features in Ontario and the Midwestern States are described as "furrows", "grooves", or "flutings" parallel to the direction of movement of the ice.[2] While many are undoubtedly groovings in a till sheet, the writer suggests that many were also drumlinoids, now almost obliterated by the processes of solifluction, normal erosion, and lacustrine action.

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[1] Armstrong, J. W., and H. W. Tipper. Glaciation in North Central British Columbia, Amer. Jour. Sci., 246, 1948, p. 283-310.

[2] See, for example -

Alden, W. C. Drumlins of Southeastern Wisconsin, Bull. 273, U. S. Geol. Surv., Washington, 1905.

Chapman, L. J., and D. F. Putnam. The Physiography of Southern Ontario, Univ. of Toronto Press, 1951.

Leverett, F. The Pleistocene of Indiana and Michigan, Monograph 53, U.S. Geol. Surv., Washington, 1915.

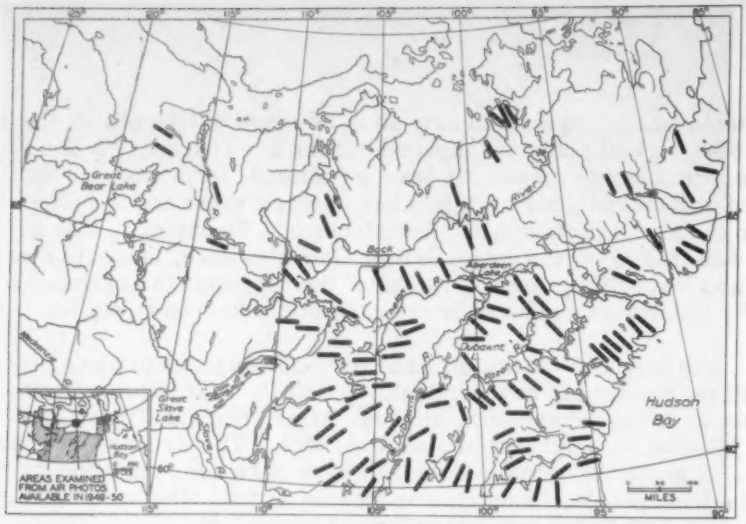
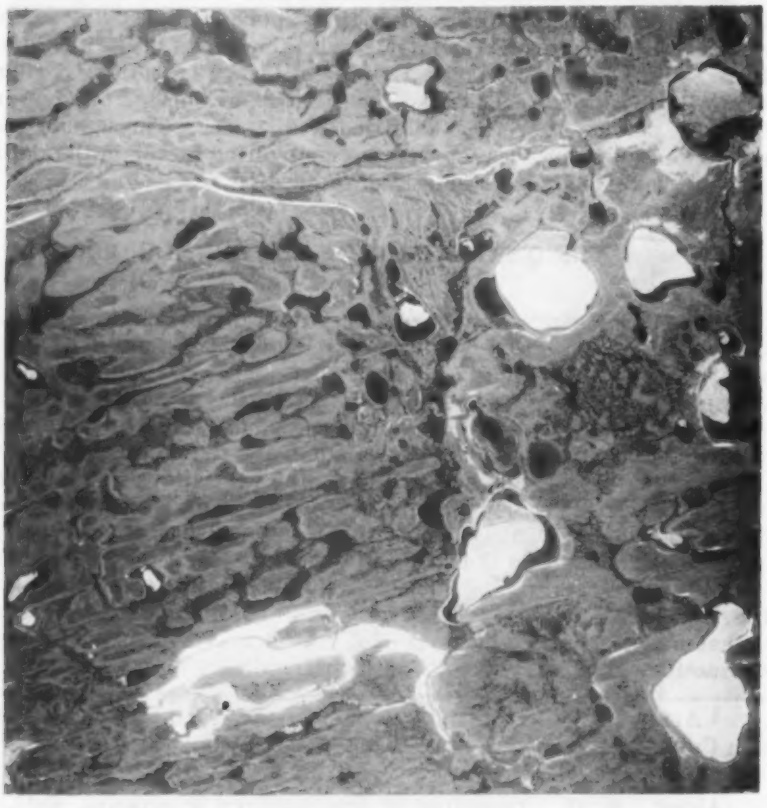


Fig. 3 ORIENTATION AND DISTRIBUTION OF DRUMLINOIDS IN THE BARREN GROUNDS
SYMBOLS REPRESENT "FIELDS"



R.C.A.F. Photo.

Fig. 4. A vertical photograph taken from 20,000 feet showing the watershed between the Back and Thelon Rivers at (65° 13' Lat. 101° 15' Long.). This serves as an illustration of the difficulty of accurately determining the direction of ice movement. Note several curved drumlinoids.

Distributed throughout the Barren Grounds there are numerous areas dominated variously by plains, knobs, or ridges of outcropping bedrock. As a rule, no drumlinoids are found on these bedrock-controlled surfaces. However, one outstanding exception to this general rule is to be found in the northeastern portion of the District of Keewatin. Here, some 50 miles to the west of Christie Lake in the Rae Isthmus, there are isolated groups of drumlinoids lying on what appears in the aerial photographs to be a bedrock-controlled surface.

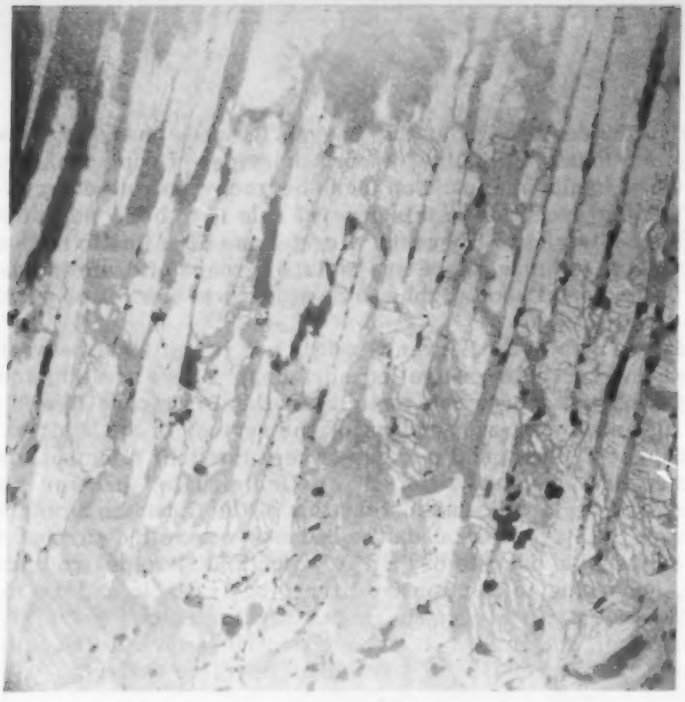
Many areas in the Barren Grounds are transitional between the bedrock-controlled and the drift-controlled surfaces. These are situated for the most part in the northeasternmost portions in the District of Keewatin, and in the western and southwestern borders of the region, in the District of Mackenzie, In both of these regions, and in others where the drift thins out, the frequency of drumlinoids declines, and "fields" or "individuals" become isolated. In the forest-covered regions of the continuation of the Canadian Shield to the west and southwest of the Barren Grounds the bedrock-controlled surface dominates, but there are extensive pockets of drift in which drumlinoids are found. In general, however, according to the limited literature available and the rather extensive study of the aerial photographs of the regions made by the writer, it can be stated that the drumlinoids are the most widely-distributed and characteristic landform of the Barren Grounds and the immediate environs.

THE ORIENTATION OF THE DRUMLINOIDS

The orientation of the drumlinoids can be best understood by a study of the accompanying map of distribution and orientation. (Fig. 3) In general, the overall pattern is one of a fan-like spreading from Hudson Bay, with the main directions of orientation being roughly east to west, southeast to northwest, and northeast to southwest. Within this general pattern there are a number of subordinate patterns oriented at oblique angles to the main directions of movement. There are also a few complex "crossed patterns". These departures from the overall pattern of orientation probably express more localized movements of the ice sheet under local controls. They may also signify subsequent, comparatively minor, ice movements after the major advance, caused either by adjustments to equilibrium, or by a readvance of a lobe of the ice sheet.

The direction of ice movement over an area where drumlinoids are found is often clearly indicated through an intensive examination of the aerial photographs of the area. Stoss and lee ends on the drumlinoids, crag and tail features, as well as weakly formed drumlinoids and groovings, usually show not only the bearing, but also the direction of the ice movement. However, in many cases such direct evidence is lacking in the aerial photographs, and other sources of information must be considered.

An example of the necessity of referring to evidence other than that on the aerial photographs may be cited in the area to the west of Rankin Inlet and to the south of Chesterfield Inlet. In this area, the drumlinoids are oriented in a northwest-southeast direction. From the aerial photographs one cannot be certain whether or not the direction of ice movement was from the northwest or from the southeast. On the basis of Tyrrell's theory of a Keewatin ice centre or centres, one would conclude that the ice movement was from the northwest.



R.C.A.F. Photo

Fig.5. A vertical photo taken from 20,000 feet near Eskimo Point on the Hudson Bay Coast (61° 8' Lat. 94° 43' Long.). This serves as an illustration of the partial destruction of drumlinoids by a marine inundation and by solifluction. Note the abandoned beaches in the lower right.

R.C.A.F. Photo.

Fig.6. An early low oblique taken from 9000 feet looking north from near the headwaters of the Thelon River (62° 47' Lat. 105° 55' Long.). This is an example of the predominance of the long narrow forms of drumlinoids which at least appear to be depositional forms. Drumlinoids similar to these cover many hundreds of square miles of the Barren Grounds.

On the other hand, more recent work, such as that of Flint,[1] and more especially that of Bird,[2] who bases his conclusions on field observations and a study of aerial photographs, demonstrates that the latest movement of the ice sheet in this region was from the southeast rather than the northwest. There is no reason to doubt that the drumlinoids parallel the major movements of an ice sheet as Armstrong, Bird, Chapman and Putnam, and others have demonstrated. In the Barren Grounds this orientation substantiates the hypothesis of a generally westward, fan-like spreading of the latest major advances of the Wisconsin Ice Sheet.

ORIGIN AND SUGGESTED MODE OF FORMATION

There is abundant evidence both on aerial photographs and in a number of publications that drumlinoids, like drumlins, are glacial in origin. Their mode of formation is the perplexing problem. Whether drumlinoids are forms of deposition (the heaping or plastering-on of drift), of erosion (the grooving or fluting of drift), or of some other process of forming elongated mounds or undulations of glacial materials with associated groovings remains to be definitely determined.

The thesis that a renewed glaciation or a readvancing ice sheet "ploughed" furrows in a previously deposited ground moraine does not seem to be the complete answer to the problem in the Barren Grounds. Aerial photographs give the impression of a series of long, parallel furrows, but a closer examination shows that the "ridges" between the furrows are a succession of similarly aligned features, in some places head to tail, but for the most part slightly overlapping in alignment. Also, the "ridges" or drumlinoids have tapered or rounded ends, strongly suggesting their individuality as deposited features rather than a continual series of ridges on either side of a furrowed hollow. The resemblance of the drumlinoids to drumlins, as well as their streamlined form, certainly indicates that they are a closely related phenomenon and are probably mainly depositional in origin.

Chapman and Putnam, and Armstrong and Tipper point out that both drumlinoids and drumlins may be fluted or grooved, and that these long and usually very straight flutings can lead to no other conclusion than that they were scoured out by an ice sheet. There is much evidence to support this, especially where Chapman and Putnam, and H.T.U. Smith[3] assert that in some places in Southern Ontario and in the Mackenzie Basin, respectively, the soft bedrock itself has been scoured out in a similar manner. It must be concluded that some form of erosion is combined with a depositional process in the formation of drumlinoids, or, that fluting and grooving may be a separate phenomenon related in some way to drumlins and drumlinoids.

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[1] Flint, R.F. Growth of the North American Ice Sheet during the Wisconsin Age, Bull. Geol. Soc. Amer., 54, p. 943.

[2] Bird, J.B. The Physiography of the Middle and Lower Thelon Basin, Geographical Bulletin, 1, 1951, p. 14-29.

[3] Smith, H.T.U. Giant Glacial Grooves in Northwestern Canada, Amer. Jour. Sci., 246, 1948, p. 503-514.

Assuming that drumlinoids are mainly depositional features, the problem arises as to where their deposition took place in relation to the ice sheet as a whole. Nearly all drumlins seem to have been formed near the marginal areas of the ice, just "upstream" from the terminal moraines, or on almost level areas where some topographic feature, such as an escarpment or a basin, has interfered with the flow of the ice sheet. Drumlinoids, on the other hand, may be seen almost anywhere throughout the entire area covered by the ice sheet, and are particularly prevalent near the assumed "Keewatin Centre".

If the drumlinoid features were depositional and related in some way to drumlins, or even if they were the result of erosion, it seems safe to assume that they were formed during a period of maximum movement of the ice sheet. This period is generally associated with the advancing stage or stages. This is also strongly suggested by the parallelism and orientation of the drumlinoids. That a number of later movements or adjustments to equilibrium took place is apparently manifested by the irregular and "crossed" patterns of drumlinoid orientation, and by the several extensive drumlinoid patterns meeting at oblique angles, especially to the south of Aberdeen Lake.

As drumlinoids are apparently the result of the processes of both glaciological and geomorphological factors, elements of both processes should be considered concerning their formation.

Glaciological Factors

It is considered probabl that the first active movement of the Wisconsin glaciation began in the highlands of Quebec-Labrador, where the altitude and the heavy precipitation would incite ice accumulation.[1] Meanwhile, the lower areas to the west, including the Barren Grounds, would be the site of ever-increasing depths of snow and ice brought about by the excess of accumulation over ablation by the progressively cooling glacial climate. Ice movement in these western areas would be limited to very localized places of topographical control, the relatively thin ice sheets, on the whole, being quite passive. As the accumulation continued, especially in the east, and the ice-shed moved progressively farther and farther to the west and southwest, the westerly districts would be successively transformed from regions of passive to regions of active glaciation until ultimately the state of equilibrium between accumulation and ablation was reached and the continental glacier would terminate. Once this stage was reached, further movement would tend to be limited to the margins of the ice sheet, or to generally localized areas throughout the ice sheet, where climatic fluctuations would influence the regime and cause the ice to make movements to adjust to equilibrium.[2] Thus it is thought that once the main advance had been made, further movements of the ice sheet were more or less confined to the margins, or, in the case of the Barren Grounds, very favourable places throughout the whole ice sheet, even during the waning period.

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[1] Flint, R.F. Glacial Geology and the Pleistocene Epoch, Wiley and Sons, New York, 1948.

[2] Ibid.

The effects of radiation, and, at a later stage, the even more effective influences of convection[1] would tend to keep the inland areas of the ice in a passive or stagnating condition, preventing any but very local movements. Thus it is thought that the drumlinoids throughout the Barren Grounds, and possibly those elsewhere, were formed during the advancing stages of the Wisconsin glaciation.

Geomorphological Factors

Assuming that drumlinoids are a variation of landform belonging to the same class as drumlins, their formation would appear to be the function of the movement of an ice sheet over the surface of the ground where a certain amount of regolith or drift material is available for moulding by the ice. Where a decisive equilibrium of conditions is reached, the loose materials on the ground surface and in the basal layers of the ice will be moulded into a streamlined form of a definite size and shape. When these conditions are changed, there would be corresponding changes in the size and shape of the resulting landform. The nature of the changes is not fully known, but there are a number of factors which seem to have had an influence.

Wilson suggests that the adhesiveness of the till is one of the more important conditions.[2] Where the till is adhesive, drumlins would be the ideal shape in equilibrium with all of the forces, but where it is not adhesive, drumlinoids might be formed. This may well be a factor of considerable importance, especially in the Barren Grounds where there are only limited areas where clayey, and thus adhesive, materials would be available for incorporation into the till of an ice sheet. The extensive areas of sandstones and conglomerates throughout the central regions of the Barren Grounds, as well as the resistant nature of the Precambrian granites and gneisses would tend to preclude the formation of large amounts of clayey (adhesive) materials. The predominantly sandy drumlinoids in the Cree Lake region of Saskatchewan[3] can be cited as an example of the formation of drumlinoids in non-adhesive materials.

Chapman and Putnam point out that the drumlins of Southern Ontario are composed largely of loamy till, and that where the till is too clay-rich, drumlinoids rather than drumlins are forms. This, and the Cree Lake example, suggest that a certain degree of adhesiveness in the drift materials is necessary for the formation of drumlins. This seems to indicate that drumlinoids would be formed where the materials are not sufficiently adhesive, or are, perhaps, too sticky.

Another important condition affecting the "equilibrium" postulated above, appears to be the depth of till, drift, or regolith materials available in any particular region for the formation of drumlinoids. In the main, the till mantle over the bedrock in the drumlin fields is comparatively thick. In the Barren

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[1] Ahlmann, H.W. Glaciological Research on the North Atlantic Coasts, Research Ser. 1, Royal Geographical Society, London, 1948.

[2] Wilson, J.T. Drumlins of Southwest Nova Scotia, Trans. Roy. Soc. Can., 32, Sec. IV, 1938.

[3] Sproule, J.C. Pleistocene Geology of the Cree Lake Region, Saskatchewan, Trans. Roy. Soc. Can., 33, Sec. IV, 1939.

Grounds, where there are drumlinoids, the till is known or believed to be quite thin. Deane makes a similar observation in his study of the Lake Simco region of Ontario where drumlinoid features are found.[1] It is suggested then that the availability of suitable materials may have had an important influence on the drumlinoid forming process.

Armstrong and Tipper, on the other hand, state that the drumlinoids of the Nechako Plateau lie upon considerable depths of till, in some cases as much as 400 feet deep.[2] The same authors consider that drumlinoids were formed when a lightly loaded ice sheet overrode the thick till deposits of an earlier ice sheet. In the process, they surmise, the till was grooved and reshaped into drumlinoids. Judging from the aerial photographs of the Barren Grounds, the drumlinoids there rarely appear to overlie thick deposits of till. From this, and the observations of Deane and others, it seems that drumlinoids are not necessarily formed only when a lightly loaded ice sheet overrides thick till deposits.

Many geologists consider that drumlins were originally formed about nucleii of bedrock or till obstructions which lowered the speed of the moving ice, and led to the deposition of till in the lee of the obstruction, the drumlins then being built up by the accretion or plastering-on of till materials over the original nucleus. The initial accumulation having been made, the drumlins would then promote their own development with the flow of the ice tending to keep the drumlins in a perfect streamline shape.

A similar hypothesis might be advanced for the formation of drumlinoids. Where the drift cover is thin there would be innumerable bedrock bosses or projections, as well as locally increased depths in the drift mantle, which could form potential nucleii for the drumlinoids. But if drumlinoids were formed mainly by the accumulation of drift around a nucleus, one would expect their distribution to be far more irregular than it is. Also this hypothesis could not explain the apparent uniformity of lateral distances between drumlinoids throughout many areas. However, such nucleii may well have been a contributing factor in drumlinoid formation.

It seems reasonable to suppose that the spindle-shaped form of the drumlinoid represents a greater velocity of ice movement than that which formed the more ovoid form of the drumlin, the greater velocity tending to keep the lines of flow parallel. When combined with the evidence of a relative scarcity of till, in the Barren Grounds at least, and in view of the idea expressed above that the really effective ice movement did not begin until a rather deep and extensive ice cover had accumulated: a rapid drumlinizing movement could take place during the advancing stages of an ice sheet without necessarily encountering the inhibiting effect of an ice terminus, such as was generally found just "downstream" from the regions where drumlinoids were formed.

The ovoid shape of drumlins suggests that the flow of ice was mainly around rather than over the till of which a drumlin is composed. For if the flow was, in the main, over the obstruction, the stoss end of the drumlin would

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[1] Deane, R. E. Pleistocene Geology of the Lake Simcoe District, Ontario, Mem. 256, Geol. Surv. Can., Ottawa, 1951.

[2] Armstrong and Tipper. Op. cit., p. 286.

tend to be flattened or ramped so that the resulting landform would resemble a roche moutonné rather than a drumlin. Most, if not all drumlinoids, appear to have a stoss and lee effect to a greater or lesser degree. From this it is presumed that the flow of ice was also mainly around rather than over the drumlinoids. Moreover, the elongated form and generally flattened summit suggests that the drumlinoid is the form of least resistance to a considerably more rapid ice movement than that which formed the drumlins. If there was comparatively little till in the ice to begin with, deposition by the ice sheet would obviously be limited. On the other hand, even if there were considerable amounts of till in the ice sheet, a high velocity would enable the ice to carry most of the load, depositing only a little where obstructions were met, or where the forces forming the drumlinoids came into equilibrium. In either the case of limited amounts of loose surface material available for deposition, or the case of a rapid ice flow - the resulting landform would tend to have the long, narrow characteristics of the drumlinoid.

At the point where a drumlinoid was originated, probably where there was an obstruction, the rate of ice flow, both at the obstruction and for some distance "upstream" from the obstruction, would be decreased. Meanwhile, the speed of the ice flowing immediately on either side, and possibly over the top of the obstruction, would be relatively increased. Assuming that the ice flow was a movement along an infinite number of parallel lines perpendicular to the ice front, as the parallel forms of the drumlinoids appear to indicate, this locally increased velocity would tend to erode groovings on either side of the till deposited where the ice was slowed at the obstruction. Once the combined depositional and erosional process had started it would probably tend to continue over a great distance; the process being cumulative once it had been initiated.

There were, undoubtedly, other factors besides those mentioned above, which had an influence on the formation of drumlinoids. Some drumlinoids appear to have been formed of stratified or kame materials; it is thought that in these cases the mode of formation was a redrumlinization of previously deposited materials, which had probably originated from meltwater activities during a temporary recession of the ice sheet. However, taken as a whole, the formation of drumlinoids appears to be mainly a function of the nature of the materials, the load and velocity of the ice sheet, and the mechanics of continental ice sheet movement.

SUMMARY

The drumlin-like landforms that Tyrrell described in 1896 as "drumlinoids" are the most characteristic features of glacial origin in the Barren Grounds. Their widespread distribution throughout the glacial-drift covered portions of this region, as well as many other regions in more southerly latitudes covered by glacial materials, implies that the drumlinoids are a rather significant landform developed under a continental glaciation. As yet, the processes involved in their formation can only be speculated upon, or at best, drumlinoids might be regarded as being related to drumlins and therefore formed in a similar manner. There are a number of glaciological and geomorphological factors apparently affecting their formation. Some of these are discussed here,

but, until more detailed investigations have been carried out, especially in field surveys, and a definite classification of such features has been evolved, drumlinoids can only be definitely described as widespread features which resulted from both depositional and erosional processes of a continental ice sheet.

Further study concerning the nature and orientations of the drumlinoids in the Barren Grounds, and elsewhere, along with an investigation into the processes involved in their origin should bring to light much useful information. Such information would not only concern glacial geology and geomorphology, but also glaciology, and, indirectly, glacial climatology.

FISSURES AND MUD CIRCLES ON CORNWALLIS ISLAND, N.W.T.[1]

J. Ross Mackay

University of British Columbia

Cornwallis Island is in the approximate geographic centre of the Canadian Arctic Archipelago. If the extent of vegetation covering were used as a criterion, it must also be near to the pole of barrenness for the islands. Most of the surface is a low undulating plateau with a veneer of glacial till, some of which has been reworked by waves. Along the coastal portions there are impressive displays of raised beaches up to an altitude of roughly 500 feet. There, like the areas of till, are virtually bare and are without any continuous vegetatation covering. Probably at least 90 percent of the island can be classified as an Arctic desert. In the large expanses of bare land, some features of patterned ground are revealed with remarkable perfection. There are geometrically regular polygons, large ten foot doughnut-shaped stone circles, peat mounds with ice cores, and long striped solifluction lobes. The purpose of this paper is to discuss two types of patterned ground, namely fissures which outline large polygons, and sorted mud circles. Although they are to be found in a variety of areas, the following discussion will be restricted to fissures and sorted mud circles occurring in gravel beaches where they are most clearly shown.

FISSURES

Large fissures which form the outlines of polygons are familiar sights in many Arctic landscapes. They are present on Cornwallis Island, and are especially common in areas with coarse granular materials, such as in the gravel of raised beaches and in the sand and gravel of deltas and some floodplains.

Fissures rarely occur individually but usually in parallel sets which intersect at right angles to give a rectangular or tetragonal pattern. The rectangular pattern is well developed on beaches but the rectilinearity is lost in areas of glacial till.

The sets of fissures tend to be oriented along and across the contour. Those fissures which follow the contour may be called transverse fissures and those which trend down the steepest available slope at right angles to the contour may be called longitudinal fissures.

Detailed mapping of many fissures shows that the formation of longitudinal fissures generally preceded that of transverse fissures in all the areas which were studied. There are a number of facts which support this conclusion. A statistical count shows that the majority of transverse fissures either terminate at longitudinal ones, or if they continue their general trend across the

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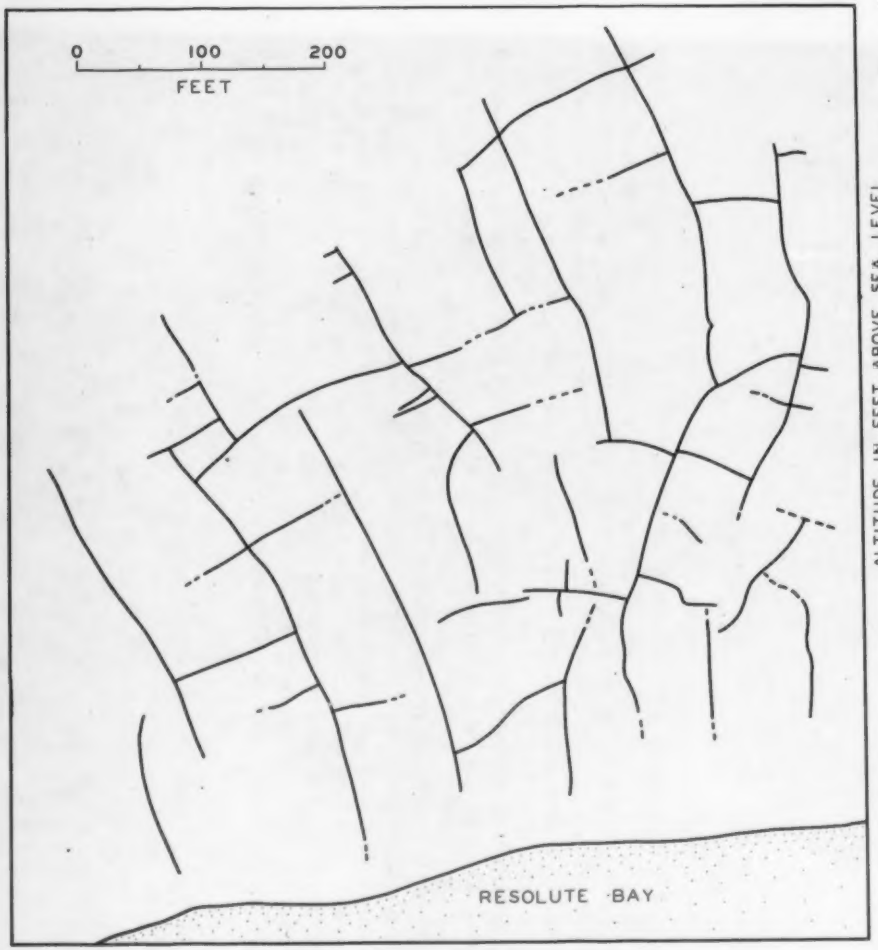
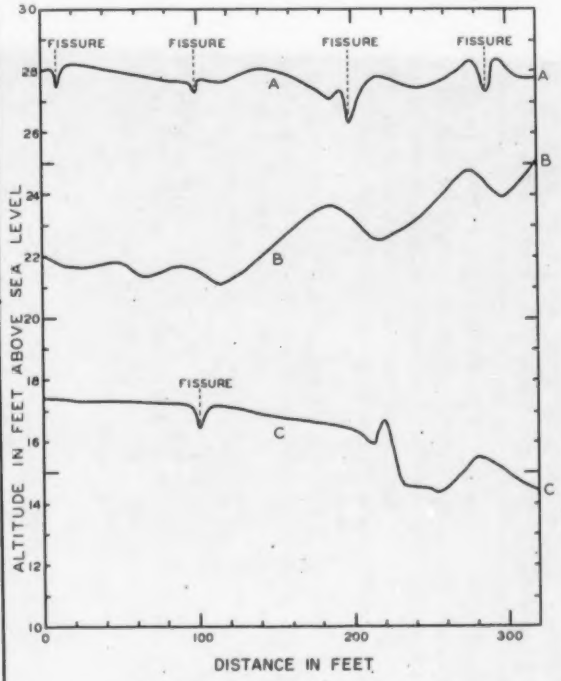
[1] Based on field investigations carried out for the Geographical Branch, Dept. of Mines and Technical Surveys, with whose permission this paper is published. Thanks are due to John Stager of the Branch, for his assistance in the field.



DISTRIBUTION OF FISSURES IN THE RESOLUTE BAY AREA

Fig. 1 The longitudinal fissures which trend downslope towards Resolute Bay are longer and more continuous than the transverse fissures, suggesting that the transverse fissures are younger than the longitudinal fissures.



BEACH RIDGE (CREST) PROFILES

Fig. 2 A, B and C are three profiles surveyed along the crests of three successive raised beaches at Resolute Bay. The raised rims of the fissures are best developed on profile A, presumably because the fissures there are the oldest because they are at the highest altitude.

longitudinal fissures, they are usually offset several feet. (Fig. 1) Transverse fissures which cut across longitudinal fissures are infrequent exceptions to the rule. The termination of the transverse fissures against the longitudinal ones indicates that they are a later development. Thus the transverse fissures are short in comparison to the longitudinal ones. The longitudinal fissures often extend downslope to within 10 feet of sea-level before their channels die out imperceptibly in the beach material. On the other hand, few transverse fissures occur within 20 or 30 feet of sea-level. Longitudinal fissures tend to have deeper and larger channels than transverse ones. All these factors point to the conclusion that longitudinal fissures usually develop before transverse ones.

In any area of homogeneous material and uniform slope the longitudinal fissures tend to be regularly spaced. In gravel beaches they are about 70 feet apart. Individual fissures may be several hundred feet long.

Each fissure is marked by a channel which varies from several inches in depth to over two feet. The stones in the channel may stand edgewise. The sides of the channels may be slightly raised above the adjacent areas. The raised rims are especially pronounced on the ridges of large gravel beaches (Fig. 2) and less prominent where the fissures cross the intervening swales.

The longitudinal and transverse fissures probably form during the long cold winters by contraction of the ground as suggested by Leffingwell for areas in northern Alaska. However, he never observed fissures in elevated deposits of sand and gravel.[1] Water which accumulates and later freezes in the cracks forms ice-wedges. His theory of contraction has recently been supported by Black who has made a detailed study of ice-wedges in Alaska.[2] Vertical ice-wedges probably underlie the channels of most fissures on Cornwallis Island. Tension is apparently relieved first by fracturing at right angles to the contour and thus down the steepest slope to form the longitudinal fissures. The fissures are lengthened seaward as the lowest beaches emerge in somewhat the same manner as an extended consequent stream maintains its seaward course. On areas where there is little or no appreciable slope, no directions are favoured for the formation of tension fractures and, therefore, many-sided polygons develop.

Several theories may be offered for the formation of the raised rims. The most probable explanation is that the growing ice-wedges press sideways and dome up the rims. This theory has been suggested by a number of observers. Thrusting may be aided by expansion as the ground warms up in summer. Possibly thin horizontal ice-lenses may form near the wedge and their cumulative thickness may accomplish some doming. Another suggestion involves the squeezing effect exerted as the summer-thawed ground freezes from the surface downward to the permafrost layer. Unfrozen material which is trapped under pressure, as in a tightening vice, might locally be forced laterally towards the fissures, thus increasing the thickness there.

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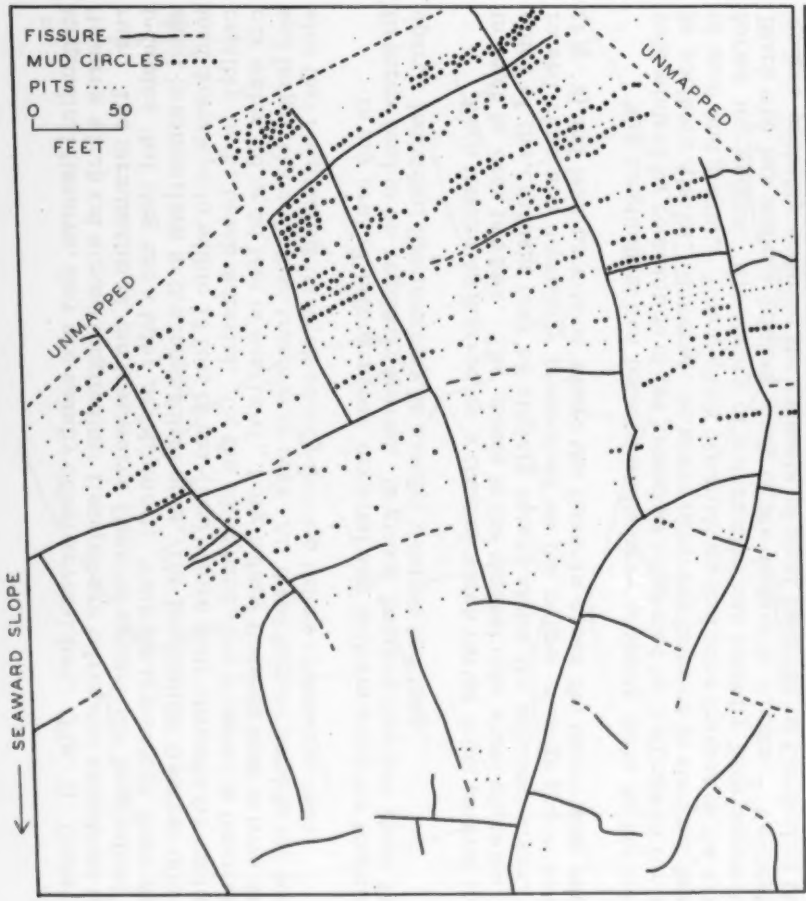
[1] Leffingwell, Ernest de K. The Canning River Region, Northern Alaska, U.S., U.S. Geol. Surv., Prof. Paper 109, 1919, p. 205-211.

[2] Black, R.F. Growth of Ice-Wedge Polygons in Permafrost near Barrow, Alaska, Bull. Geo. Soc. Am., 63, 1952, p. 1235-1236.



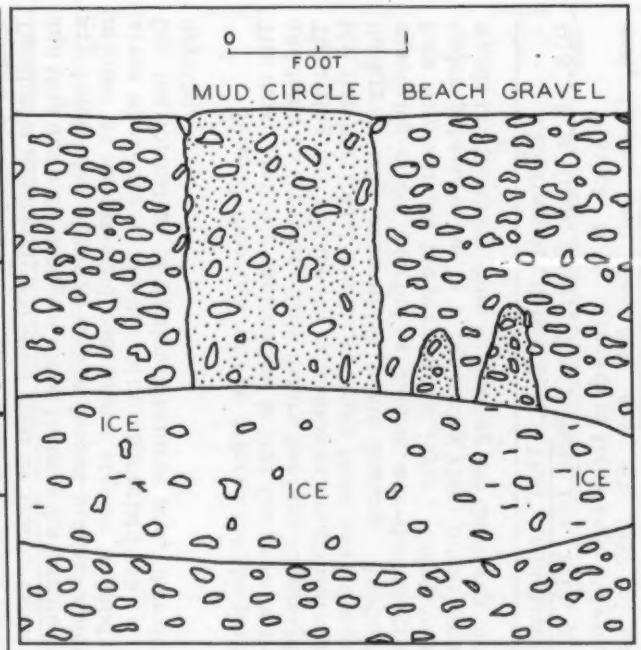


Fig. 4 CROSS SECTION OF A MUD CIRCLE. This shows the underlying ice lens and the mud plug injected into beach gravel. Two satellite plugs are shown to the right.

Fig. 3 DISTRIBUTION OF FISSURES, MUD CIRCLES AND PITS: The area shown is a portion of that covered in Fig. 1. Note how the mud circles and the pits trend along the contour. The pits are relatively more common at the lower altitudes near sea level and the mud circles at the higher altitudes.

MUD CIRCLES

Many of the gravel beaches of Cornwallis Island have a type of patterned ground which might be referred to as mud circles. The mud circles average about eight to 10 inches in diameter. They are conspicuous features because the mud circles contrast in texture and colour with the gravel of the beaches in which they occur. The mud circles usually lie along the contour and are found on both beach ridges and in the intervening swales. They may be spaced with regularity at distances of from one to five feet apart.

Excavations were made in a number of mud circles in order to determine their subsurface structure. Detailed maps of their distribution were also made. As a result, it is possible to give a fairly accurate descriptive account of their method of formation but it is much more difficult to give an accurate interpretive account of their origin.

Mud circles, like streams, may pass through a cycle of youth, maturity, and old age. The first surface expression of an embryonic mud circle is a shallow conical pit in the gravel of a raised beach. The pits or depressions are several inches to a foot in depth. They lie spaced at regular intervals along the contour. The pebbles at the bottoms of the pits are usually much less weathered than those on the ground surface. When excavations were made into the depressions, frequently mud plugs were found beneath them. The mud plugs commence at a depth of about 20 to 25 inches where they are from four to six inches in diameter. A plug is composed of a mixture of hard mud and gravel which forms a very tough cylinder. When the plugs are broken open, in summer, they are often found to be quite moist, they may ooze water, and the clay usually has bubble holes. There may be a number of plugs within an area of several square feet but those beneath depressions have the shortest distance to travel upwards before they break through to the surface. Some of the plugs rest on ice-lenses which may be three or more feet in diameter and a foot or more thick. The lenses are composed predominantly of ice with a few stones and some wafer-like fragments of clay. The growth of the lenses may bow up the overlying material and help to raise the mud plugs. The lenses may form due to locally abundant moisture, such as from seepage along fractures or from melting snow accumulated in the depressions. The growth of an ice-lens may be an effect, or even a cause, of the pits.

The pits tend to occur at lower altitudes and closer to sea-level than mud circles. (Fig. 3) With increasing altitude, the percentage of mud circles usually increases and that of the pits decreases. Few pits occur within 20 to 30 feet of sea-level, so they probably take tens to hundreds of years to form.

In youth, the mud circles are represented by plugs beneath conical pits. As the mud plugs rise, or are injected upwards, they increase in size and eventually break out into the pits. Strangely enough, they are not injected at the bottom or apex of the conical pits, but tend to break through on the sides that are towards the lower altitudes. At this stage, maturity may be considered to have commenced. The mud plugs gradually push up until they fill the depressions and may even build slightly convex mud "pies" an inch above the general beach level. (Fig. 4)

As more and more plugs reach the surface, they begin to coalesce at which stage old age may be considered to have set in. Individual plugs may eventually lose their identities as they merge to form other types of patterned ground.

The cryostatic hypothesis, favoured by Washburn for certain forms of patterned ground, may possibly explain the formation of these mud circles.[1] In the cryostatic hypothesis, debris is thought to be squeezed between downward freezing ground and the permafrost table. Upward injection would take place in areas of easiest relief. Once a mud plug has begun to rise, a number of factors operate to continue it, one being that mud plugs would remain unfrozen longer than the surrounding gravel and would then have more mobility.

The pits look as if they were formed by collapse due to removal of material at depth. Collapse might be initiated in a number of ways. The pits might be surface expressions of linear fractures formed either by contraction, as in fissures, or possibly by fracturing of the brittle upper layer during freeze-up or later. The depressions might conceivably be thermokarst phenomena formed by melting of ground ice, but this is hard to reconcile with the presence of ice-lenses beneath some plugs. Whatever the origin of the plugs and pits, it seems reasonably certain that mud circles form by the injection of plugs upwards into the pits.

SUMMARY AND CONCLUSIONS

Longitudinal and transverse fissures on the raised beaches of Cornwallis Island probably form by contraction of the ground during the cold winters. The longitudinal fissures usually form before the transverse fissures. The mud circles which occur are probably injection phenomena. They are intimately associated with pits in the gravel. In youth, plugs lie beneath pits. In maturity, the plugs break through into the pits. In old age, mud circles coalesce.

There are many interesting problems concerning fissures and mud circles that await further study. The ice-wedges need more investigation, and profitable work could be done on their depths, widths, fracture patterns on the "T" junctions between longitudinal and transverse fissures, and on the orientation of ice crystals, bubbles, and included material. The raised rims could be excavated and studied. Diggings at the lower terminuses might show whether wedges occurred beneath them and even possibly forther downslope than there is any surface indication of a channel. The depths of ice-wedges are probably related to the depth where seasonal changes of temperature cease, and this could be further investigated. The mechanism of the injection of mud plugs is not fully understood nor is the origin of the pits. A strong dye could be added to water and its appearance, if any, in mud circles noted. The function of the ice-lenses needs further explaining. The relationship between fissures and mud circles requires more study. Orientation studies could be made of the stones. Facts and theories derived from a study of fissures and mud circles in gravel might be applied to the nearby areas of glacial till where fissures and mud circles, although present, are not so clearly shown.

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[1] Washburn, A.L. Patterned Ground, Rev. Can. de Géog., 4, 1950, p. 30-43.

A study of patterned ground has some practical applications because it contributes to a knowledge of the active or annually thawed layer of ground in the Arctic. A thorough understanding of the behaviour of the active layer and the permafrost zone is essential for many engineering purposes such as the building of roads, airfields, and houses.

IVIGTUT CRYOLITE AND MODERN GREENLAND

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Dartmouth College

Early in the Second World War, the name Ivigtut was prominent in Canadian newspaper headlines. The product of its mine - cryolite - was an important reason for Canadian participation in wartime events in Greenland,[1] and Ivigtut was, for a time, the site of Canada's first established Consulate.

For almost a century ships have been calling regularly at the little settlement in Arsuk Fjord in southwest Greenland (about 140 miles northwest of Cape Farewell) bringing in supplies, and carrying away cargoes of the ice-like rock which has been in constant demand by industry. There is much about the mineral, its occurrence, the mine itself, the community, and the influence of the whole complex on Greenland affairs, to interest the geographer.

IVIGTUT

Long before Europeans first studied cryolite as a mineral curiosity about 150 years ago, it was known to the Eskimos who frequented Arsuk Fjord in latitude 61° 12' N. and longitude 48° 10' W. On the south side of the fjord about 13 miles in from the open sea, there is a small bay, from the shore of which the land slopes up gently for more than a mile before rising abruptly to the surrounding highland. The name of this attractive spot is, in Eskimo, Ivigtut, or "the place where there is plenty of vegetation". (Fig. 1) Elsewhere in the fjord, the land rises much more steeply from the shore, often with sheer cliffs of about 1,000 feet. Behind Ivigtut, the general level of the upland is about 1,600 feet. The highest peak in the vicinity is Kungnait, about 4,450 feet above sea-level, some miles seaward from the village of Ivigtut.[2] At the head of the fjord, about 10 miles from Ivigtut, Arsuk glacier flows down from the Ice-cap.

USES OF CRYOLITE

The Eskimos found cryolite on the shore at Ivigtut. This occurrence was well known locally, but the mineral had no particular use. It was first described in Europe in 1795 in connection with an exhibition of Greenland minerals held in Copenhagen.[3] The name cryolite, meaning "ice-stone", was given the mineral a few years later when it was analysed and found to contain " Fluor, Alum and Sodium". The chemical formula is now known to be Na_3AlF_6. The

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1 June 4, 1940.

2 For a description of this area see Kristiansen, Abel. Arsuk og Omegn, Gronlandsposten, 92, 1952, p. 343-44.

3 Beretninger vedrørende Grønlands Styrelse, 1, 1943, p. 494.

first considerable quantity of the mineral to reach Europe arrived in 1807 sent by the Austrian scientist Giesecke. Owing to the fortunes of war, this shipment ended up in Edinburgh and a full description of the mineral did not appear until 1822. Commercial use of cryolite was brought nearer when a Danish scientist, Julius Thomsen, made further tests on Giesecke's specimens to discover whether the mineral might not prove to be a commercial source of soda and alum. He was successful in his enquiry, and in January 1853, a hundred years ago, he patented methods for extracting soda from it. Later Howitz discovered how to use cryolite to enamel ironware.

The first commercial shipment of cryolite, 100 tons, was obtained in 1856, and in 1865 several small concerns which had done some mining at Ivigtut were combined into the Cryolite Mine and Trading Company[1] with a 20-year franchise to mine and ship the mineral. The licence was extended, with modifications from time to time, until in 1940 the whole undertaking was reorganized. In that year, the Danish Government secured a half interest in the capital of Kr. 15,000,000 to be held by a new company formed to combine the resources of the mining concern with those of the separate refining company in Copenhagen. The new concern is known as the Cryolite Company Øresund Ltd.[2]

As has already been mentioned, cryolite became valuable for enamelling ironware at an early date. Although aluminium had been produced directly from cryolite by 1855, this did not become a commercial process. The present important connection of the mineral with the aluminium industry came much later. Originally a source of soda, cryolite was in time replaced by much cheaper raw materials in Europe, although it continued to be used for this purpose in the United States until well into the present century. Eventually, the main uses of the mineral came to be in making opal glass, enamelling ironware, and primarily as a solvent in the electrolytic production of aluminium from bauxite. Today this latter use accounts for about four-fifths of the material refined in Denmark. The remainder is used for glass making, enamel and insecticide. While synthetic cryolite has been widely used in wartime, especially in Germany, Italy and Japan, and is said to be used in the Soviet Union today, the natural product, even at the prevailing price of about 10 cents a pound, appears to be preferred when it is available. The New York Times for September 13, 1953, reported that the synthetic product can, if necessary, make the industry independent of natural cryolite. At present the synthetic is slightly more expensive. On technical grounds, aluminium manufacturers are said to prefer the natural product for use in starting the electrolytic cells, or "pots". Two large companies are said to be employing 95% synthetic cryolite in their aluminium plants in the United States. Rapid growth of the synthetic cryolite industry appears due in part to a policy of stock-piling under U.S. Government direction.

CRYOLITE OCCURRENCE

Ivigtut is the sole commercial producer of cryolite, apart from possible deposits in the Soviet Union.[3] Geological conditions surrounding this almost

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1 In Danish, Kryolite Mine og Handels Selskabet.

2 In Danish, Kryolitselskabet Øresund A/S.

3 Elbo, J.G. Cryolite, and the mine at Ivigtut, West Greenland, The Polar Record, 5, 1948, p. 185-188.

unique occurrence are therefore of special interest. Cryolite occurs at Ivigtut in association with more than 75 minerals, some of them extremely rare. Impurities are usually quartz, siderite, fluorite, and sulphides of lead, zinc, iron and copper. The prevailing rock is Archaean gneiss interrupted by occasional massifs of Algonkian granite. Near the top of such a mass of granite at Ivigtut, the cryolite occurs as an egg-shaped "blister". In most parts the main mass of pure cryolite is enclosed in a layer of quartz and fluorite,[1] and in a few cases large blocks of granite apparently fell into the cryolite while it was still liquid. Weathering exposed the edge of the cryolite mass near the seashore, and some of the mineral was, until a few years ago, submerged by the waters of Arsuk Fjord. If the glacier which at one time flowed through the fjord from the ice-cap had been a hundred or so metres farther south, it might have removed this unique occurrence entirely. Search for more cryolite has, of course, been carried on intensively, not only in the Ivigtut area, but throughout Greenland. The mineral is so well known, and so easy to detect by sight, that it is most improbable that any other deposit exists near the coast, as the much-travelled natives have been on the lookout for it for a century. At the mine itself, the final limits of the cryolite mass have not yet been determined and an elaborate drilling programme is continuing. In the belief that the general structure met with at Ivigtut might repeat itself farther along Arsuk Fjord, similar drilling has been carried on near Grønnedal and there has also been some "wild-cat" drilling, all without success.

At the present rate of mining, all the cryolite will have been removed from the mine in about a decade, while shipments from stock should continue for a further decade. Ivigtut as a mining community will, therefore, cease to exist fairly soon. Such is not an unusual fate for mining developments; what is significant in this case is that when the mine ceases, so does the world's supply of natural cryolite, and also Greenland's sole present source of revenue from mining.

PRODUCTION OF CRYOLITE

The production of cryolite at Ivigtut is about as simple and economical a process as it could be. The mine is about equidistant from its two main markets in Europe and America, and is situated at the water's edge in a sheltered harbour. The deposit was originally exposed by erosion. Following about a century of mining, there is now a large pit about 200 metres long and 100 metres wide, and rather more than 75 metres deep. (Fig. 3) The bottom of this open pit is about 65 metres below sea-level. A dam, 100 metres long, protects the pit from flooding by the sea, and has also served to reclaim the part of the mineral body formerly under water.

As a community, Ivigtut is, of course, unusually laid out. Where the village green is found in many small settlements, Ivigtut has a large, deep excavation. Houses, workshops and other buildings are grouped around it - so near that a lump of granite or cryolite may enter the window or even fall through the roof when blasting is going on. (Fig. 1) This risk has a disciplining effect

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[1] Information from Kryolit, udgivet af Kryolitselskabet Øresund A/S Copenhagen, 1950; Greenland, Vol. 1, Oxford University Press, 1928, and discussions at the mine with the late Dr. Richard Bøgvad.

Fig.1 Ivigtut Settlement mine and vessel loading cryolite. Grønnedal in background.

Fig.2 Blasting materials at the cryolite mine, Ivigtut.

Fig.3 Ivigtut Sea wall with cryolite mine in foreground.

Fig.4. Ivigtut Homes of mine officials. Arsuk Fiord in background.

Fig.5. The Greenland village of Arsuk near Ivigtut.

Fig.6. Cryolite stockpile awaiting shipment to Ivigtut.

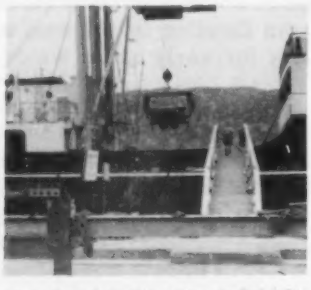

Fig.7. Car of cryolite being loaded into vessel at Ivigtut.

on community activities. Everyone from the small children to the general manager is trained to take cover when the sirens blow. During my most recent visit, the chief engineer was almost killed by a lump of rock that struck him while he was at his desk a hundred yards from the pit.

The mining techniques in use today[1] consist of blasting the granite "overburden" down into the pit bottom, where it is loaded by power shovels into enormous "dumptor" trucks. These carry the waste rock up through a 500 metre-long tunnel (built in 1948) to the surface, where it is dumped either along the foreshore, or farther inland, to provide additional cryolite storage space. About three quarters of a ton of granite is removed for each ton of cryolite produced. The cryolite itself, which is softer than granite, is blasted down with lighter charges[2] and removed in the same way. Rough sorting takes place at the storage space near the quay, and any obvious masses of fluorite are excluded. (Fig. 6) Narrow gauge tracks lead from the storage space for the short distance to the quay, where the small trucks are lifted by an electric crane, and the mineral is dumped into the ship's hold. (Fig. 7)

At Philadelphia the ore is removed mechanically by a travelling grab, is carried by a moving belt, and finally dropped into standard railroad wagons for conveyance to the refinery at Natrona, Pa. Curiously enough, unloading of the cryolite in Copenhagen appears less efficient, although perhaps no more expensive. Men dig the mineral out of the ship's hold and load it into steel skips which are then hauled two at a time in trucks or horse-drawn wagons to the nearby refinery. At one time, Danish Government revenue from the mine was calculated from the number of cubic metres of cryolite shipped from Ivigtut. Old photographs show the mineral stacked neatly on the foreshore in rectangular masses, like piles of cord-wood, to facilitate measurement. Government revenue now comes, like that of other shareholders, from the corporation's profits.

Since 1865 cryolite has been shipped regularly to Philadelphia where the Pennsylvania Salt Manufacturing Company has been the sole purchasing agent for North and South America. Until 1940, Canadian users of cryolite secured their requirements from this source. During the war years, the cryolite normally shipped to Copenhagen was available for direct shipment to Canada, where it was imported by the Aluminium Company of Canada (Fig. 8). Since 1945, this Company has secured its requirements in the form of refined cryolite from Copenhagen.

Production of cryolite at Ivigtut in the years from 1865 to 1922 averaged about 8,700 metric tons per annum, but from 1923 until 1939 the export amounted to approximately 27,800 metric tons and from 1940 to 1953 inclusive, approximately 46,300 metric tons a year.

The magnitude of the immediate pre-war rise is illustrated by the figures for 1933 and 1939, namely, 10,351 tons and 56,455 tons respectively. These increases represented growth in the aluminium industry, as well as general expansion in other uses of cryolite. About 80 to 90 per cent of the refined

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[1] For earlier methods see Elbo. Op. cit., p. 186.

[2] In 1951 explosives used at the mine were manufactured in Canada. (Fig. 2)

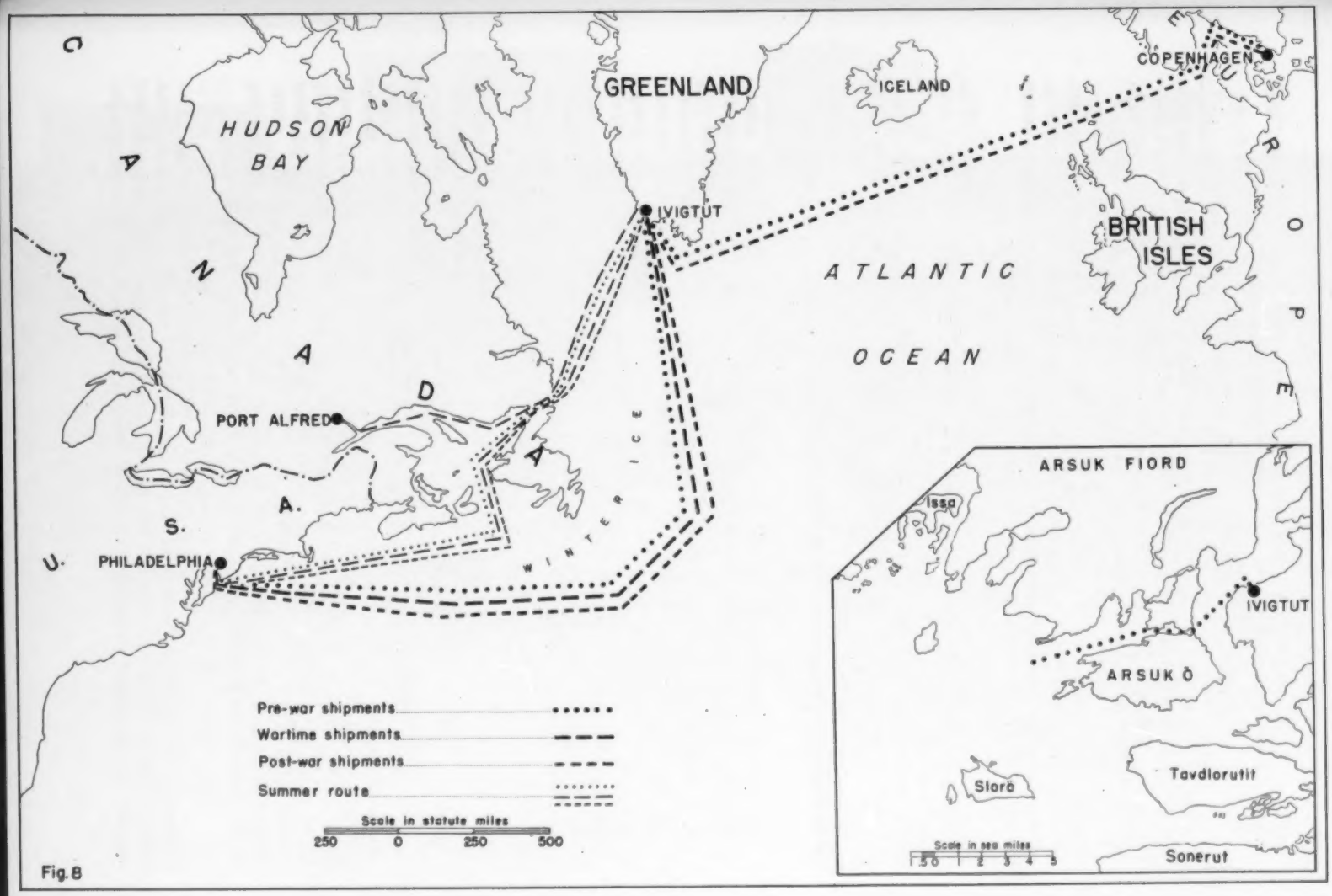
GREENLAND
ICELAND
COPENHAGEN
HUDSON BAY
IVIGTUT
BRITISH ISLES
ATLANTIC OCEAN
PORT ALFRED
PHILADELPHIA
WINTER ICE
ARSUK FIORD
Issø
IVIGTUT
ARSUK Ö
Sløro
Tavdlorutit
Sonerut
Pre-war shipments
Wartime shipments
Post-war shipments
Summer route
Scale in statute miles
250 0 250 500
Scale in sea miles

Fig. 8

cryolite delivered from Copenhagen is used in aluminium production and the balance is shared by the glass and enamelling works. Formerly, from 30 to 40 per cent was used by the latter. Before the war, the Pennsylvania Salt Manufacturing Company in the U.S.A. delivered at least 80 to 90 per cent to the glass, enamelling and cement factories, whereas the balance was sold to the aluminium industry. Since the war, with restrictions of various sorts in force, the proportion is the reverse. However, this may change at very short notice.

TABLE I

Exports of Raw Ore from Ivigtut, 1940-1953, in Metric Tons

Year	To Europe	To U.S.A.	Total
1940	0	42.970	42.970
1941	0	59.053	59.053
1942	0	85.903	85.903
1943	0	47.244	47.244
1944	0	15.774	15.774
1945	9.249	15.854	25.103
1946	20.031	10.179	30.210
1947	20.875	19.483	40.358
1948	24.972	2.135	27.107
1949	28.639	18.177	46.816
1950	28.865	19.384	48.117
1951	33.140	34.384	67.524
1952	39.360	25.899	65.259
1953 (estimated)	30.000	17.000	47.000

From the opening of the mine until 1939, cryolite extracted from the Ivigtut deposit totalled about one million tons. During this period there has been a significant change in the proportion shipped to Copenhagen and Philadelphia. Until the turn of the century, the American market consumed about double that of the European market, due largely to the continued use of cryolite for making soda in the United States. During the present century, Copenhagen has taken the lead in a proportion usually about two to one. Of the Copenhagen share, more than 99.5 per cent eventually leaves Denmark for about 30 different countries, but most of it is used in Europe. In 1951, the mine produced about 110,000 tons of crude cryolite, of which two-thirds was exported and one-third was stock-piled. Almost exactly a half of the export went to each market - Copenhagen and Philadelphia. This was an exceptionally high proportion for the United States, and almost double the tonnage of the previous year. As stock-piling, the availability of suitable shipping, and other factors enter into exports, the year to year tonnages do not necessarily represent use of cryolite at that particular time. (Fig. 9)

Canadian needs for refined cryolite, before 1940, were met from the United States. During the war, crude cryolite was shipped direct from Ivigtut

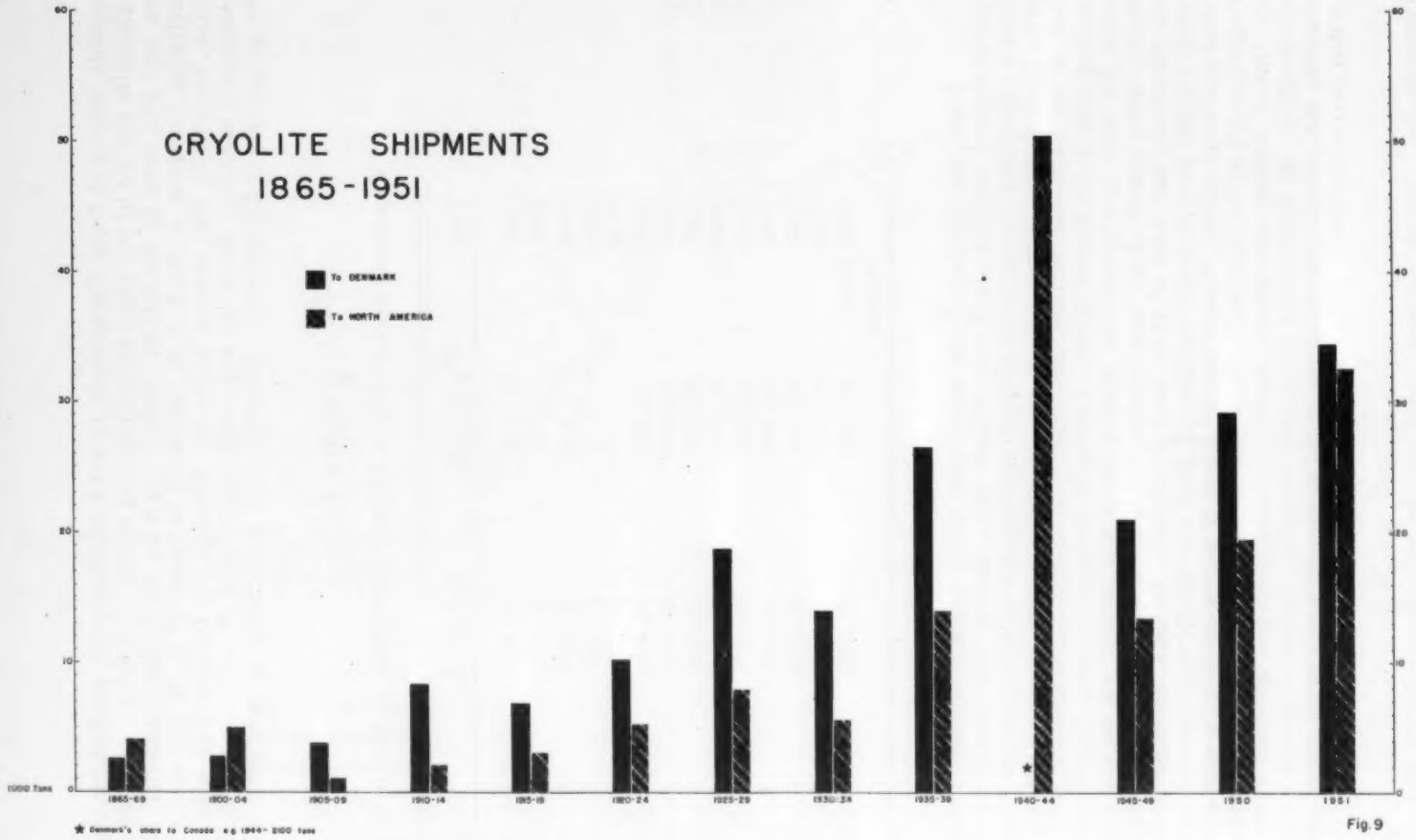
CRYOLITE SHIPMENTS
1865-1951
To DENMARK
To NORTH AMERICA
1000 Tons
60
50
40
30
20
10
0
1865-69
1900-04
1905-09
1910-14
1915-19
1920-24
1925-29
1930-34
1935-39
1940-44
1945-49
1950
1951
★ Denmark's share to Canada e.g. 1944 - 8100 tons

Fig. 9

to Port Alfred for refining in Canada. Following the war, the former policy was not resumed; instead refined cryolite has been exported direct from Copenhagen. It is believed that the Canadian company now developing new aluminium producing facilities, such as those at Kitimat, B.C., is interested in returning to the wartime practice of obtaining raw cryolite from Greenland for refining in Canada. Such direct shipments might lead to an exchange of other goods between Canada and Greenland, as in the war years.

CRYOLITE REFINING

There is no need to discuss cryolite refining in detail at this time.[1] The process is essentially a physical one, and is highly complex. The purpose is to produce two grades of refined cryolite, one for the aluminium industry - 99.2% pure, and the other for the manufacture of glass and enamelware - 98% pure. Specifications for both are mainly concerned with the iron and sulphide impurities, and further, with the amounts of quartz and calcium present. The presence of fluorides other than cryolite are less significant. The sodium content of cryolite is important as it is used as the basis for computing the price.

The refining process has some points of special interest, because it consists of retaining the mass of "rock" as the finished product, and removing various metallic and other impurities from it. Thus, lead or copper sulphides are regarded at this stage as impurities to be removed, although they are also by-products which have value.

Methods used in refining, make use of the following characteristics of the various constituents:

(a) Colour and general appearance. This is the basis for rough hand-sorting on a moving belt.

(b) Magnetism. This is used to remove fragments of iron.

(c) Specific gravity. The specific gravity of cryolite being 3.00, while various minerals remaining are much higher, permits gravity separation (wet and dry) by means of jigs, tables and air-float tables.

(d) Surface characteristics. These permit the use of various reagents to separate out impurities remaining by flotation.

(e) Hardness. Finally the remaining material includes cryolite, fluorite and quartz, which can be separated by crushing, grinding and screening.

Various stages of filtering, drying and blowing finally give the required white powder.

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[1] See Kryolit. Op. cit., p. 9-14, for details of the processes.

Incidental to the separation of cryolite are various by-products, all of which can be sold, except the quartz. For example, fluorite and hagemannite go to the iron industry as fluxes; siderite is sold to iron works for the manufacture of iron and a small amount is used for making welding electrodes, after the material has gone through a refining process; lead ore (with 0.7% silver), copper and zinc ores are sold to refineries. A fairly recent product of the industry is "Cryocide" a mixture of cryolite and hagemannite, used as an insecticide.

IVIGTUT AND GREENLAND

Some idea of the value of the small Ivigtut mine to Denmark can be obtained from the fact that in a recent year (1949) it brought a return of about five million kroner for raw cryolite exported to the U.S.A., and about 18 million kroner for refined cryolite sold to Copenhagen - a total revenue of about four million dollars.[1] In 1950, the direct cryolite income to the Danish Government for use in Greenland was about $800,000 (4,700,000 kroner) based on the Government's 50% share ownership. This income does not include taxes paid by the Company in Denmark, nor incidental revenues collected directly from the Ivigtut settlement for the Greenland Treasury. While this income is very welcome, the cryolite mine no longer meets the deficit on the Greenland economy, as was once the case. For example, the Greenland Administration balance sheet for 1950-51 showed a net loss of more than $4,000,000 or roughly 26,000,000 kroner.[2]

Entirely apart from its value as a source of revenue, the Ivigtut mine has had interesting consequences for Greenland - and the end is not yet. Until 1940, the settlement was a European enclave in an essentially native Greenland, completely separate from it in every way. Its workmen and administrative staff had no links with the rest of the country, and Greenlanders were not allowed within the Ivigtut concession. This was due to the strict policy of protecting the Greenlanders and their economy from unregulated outside influences. Ivigtut was, administratively, not a part of Greenland, but of Denmark. The miners were recruited in Copenhagen for a period of years; they reached Greenland on the Cryolite Company ship, and returned direct to Europe at the end of their contracts. No Greenlanders were employed at the mine, and the natives of Arsuk, a nearby village, were forbidden to approach the settlement. Operations of the mine were not reported in Greenland Administration published records, nor was the settlement included in the Greenland Census. The concession area was tax-free from customs and excise duties. In material comforts, Ivigtut was a typical mining camp, and in extraordinary contrast to the not-distant native sealing villages, and even the larger settlements where Danish administrators made their home.

The Nazi invasion of Denmark on April 9, 1940, cut Ivigtut off from its European sources of mining equipment, and of food and other supplies. It also stopped the annual movement of miners. Fortunately, the Company steamer,

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[1] Kryolit. Op. cit., p. 15.

[2] Report on Greenland, 1952, p. 44.

"Julius Thomsen", had left Copenhagen a few days before the invasion.[1] This veteran vessel not only survived the Greenland ice-floes throughout the war, but also five years of shuttling between Ivigtut and New York, and is still used in coastal traffic in west Greenland.

Title to the cryolite mine was taken over in June 1940 by the Greenland Administration, which retained control until 1945. While this did something to bring the mining community into closer contact with the rest of Greenland, the concession area remained beyond the pale for Greenlanders, and although a few miners travelled along the coast in the Company ship, they usually took their vacations in the United States or Canada. New miners were recruited from time to time in Canada. Supplies for the mine, as for the rest of the country, were secured from Canada and the United States. At the end of the war in 1945, the Danish Government took over its 50% share of the Company capital and with it effective control over its policies. Within the next few years, many changes took place in Greenland due to the determination to speed up integration of the colony with Denmark. The consequences to Ivigtut have been considerable.

While there are still (in 1953) no native Greenland miners at the settlement, and the mine continues to be operated independently of the Greenland Administration, there have been important changes there. About two dozen Greenlanders are employed in service jobs in the community, and the ban on visits to the settlement by Greenlanders has been lifted. Ivigtut residents are now taxed on the same basis as are others in Greenland, an arrangement which brings in considerable revenue from excise taxes on liquor and tobacco. The town is incorporated in the Greenland Council constituency of Federikshaab, so that Danish miners and officials as well as Greenland hunters and fishermen, vote in elections. The two candidates in the first national election, that of 1951, were a Greenland clergyman from Arsuk village, and the Danish mine manager. The Greenlander was elected, and his relations with the mining community are apparently good.

A special characteristic of the Ivigtut community is that since 1865 it has been almost the only part of Greenland in regular contact with a foreign country,[2] as cryolite ships made regular voyages to and from Philadelphia. Until 1946 they carried supplies from North America but the dollar shortage now prevents this, and the vessels reach Ivigtut in ballast. All supplies are secured by way of Copenhagen. The long-standing association of Ivigtut with the United States was strengthened early in 1941, by the construction of a small United States Navy station at Grønnedal - about four kilometres up the fjord from the mine. Later a small United States Army base was built still closer to the mine. The latter was removed after the war. The Naval Station was turned over to Danish operation under the North Atlantic Treaty Organization in August 1951[3] and now serves as headquarters for Danish naval vessels patrolling West Greenland waters. The close contacts between Ivigtut and North America, built up since 1865 and strengthened during the war years, have now almost ceased.

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[1] For a full description of the war years at Ivigtut see -

Lerche, Otto. Grønland under adskillelsen, Ivigtut Kryolitbrud, Det Grønlandske Selaskab Aarsskrift 1946, p. 59-70. Julius Thomsen was taken as a prize by the Royal Navy, later turned over to Canada, who assigned it to the Greenland Administration with Godthaab as port of registry.

[2] Excepting of course the war years 1940-45.

[3] For a description of this see -

Lloyd, Trevor. Changes in Greenland's Defences, International Journal, VI, 1951, 2p.

IVIGTUT SETTLEMENT

What of the Ivigtut settlement today, after about a century of mining at the site? What will be its future when the cryolite deposit is exhausted?

Ivigtut is not an impressive place when first viewed from the sea, and but for a very large corrugated iron warehouse, now scarcely used,[1] a water tank, and a disused gantry, it would in summer almost blend into the surrounding greenery. The permanent population is made up of mine officials and their families, including a doctor and nurse, radio operators, and a varying number of miners, most of them single, along with a few Greenlanders - all told about 200 persons. Buildings consist of a diesel electric power-house, a heating plant which serves the whole community, workshops for maintaining mine machinery, garages, warehouses for supplies, a small store, the government radio station, well-found residential quarters for the miners, small hotel-cum-club for officials and visitors, and a number of very attractive wooden homes, most of them with gardens and green-houses. (Fig. 4) Recretation is provided by a tennis court and a bowling alley, a rifle range, boating on the fjord, excellent hunting and fishing (some of the men run trap-lines) and by European and American movies. A few cows are kept, but most food supplies are imported from Denmark. Jeeps and trucks use the very local roads, some of which are a carry-over from the wars years.

Since 1951, Ivigtut has been less isolated from Danish contacts than formerly, because of the presence of the naval contingent at Grønnedal. This makes for a small but strong social and cultural community. The standard of living is high in comparison with Denmark, and salaries make employment there attractive for persons prepared to stand the comparative isolation. Direct contact with Copenhagen is maintained by several Greenland Administration vessels which load cryolite cargoes on the return voyage to Europe. Should the need arise, Copenhagen can be reached quickly by air, using a seaplane from the naval station to Narssarssuak air base, about 175 miles east of Ivigtut, and thence by regular commercial plane.

IVIGTUT'S FUTURE

What is the future of this unusual little settlement at a time when the Danish Government is devoting great efforts and much money to modernizing Greenland? This, the only comparatively up-to-date (technologically speaking) settlement naturally attracts attention. There are those who see in Ivigtut an excellent opportunity to train young Greenlanders in the industrial and other skills so badly needed in the country. There are, however, very few highly skilled workers at the mine. The Danish engineers and technicians there are, of course, very well qualified, but the nature of their work would make it difficult for them to train more than one or two apprentices, and promising young

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[1] The warehouse was built at a time when plans were made to sort cryolite before shipment. The rock was raised by cages in a shaft, was carried by small cars along the gantry, and was dropped into appropriate bins in the warehouse. After less than a year's operation, part of the gantry was destroyed by fire. The remainder and the warehouse still stand, but are not used for their original purpose. The mine shaft was closed in 1948.

Greenlanders would be better sent to Denmark for a broad technical education. Office and other administrative work at the mine are much like that of any other commercial enterprise, and the road to such employment neces sarily lies through a good formal education in Denmark. The mining itself is strenuous and dangerous. The skills called for are use of drills, high up the steep walls of the mine, and handling explosives. As the mine will cease operations within a decade or so, hardrock mining is not likely to prove a useful trade for a young Greenlander. For these reasons, the few Greenlanders now employed at the settlement are being trained as household help, assistant cooks and mess boys. This provides them with close contact with educated Danes, and is a valuable first step to later training in Denmark.

In spite of rapid improvements in other parts of the country, Ivigtut still provides the best equipped workshops and repair facilities in Greenland, apart from air bases, which are in no sense a part of the Greenland community. In association with the Danish Naval Station, the settlement has a group of highly skilled personnel. This has led to the suggestion that, when the mine itself is closed, means should be devised to keep these facilities in use.

To estimate the merits of this proposal, something needs to be said about the comparative advantages of the Ivigtut site over other parts of west Greenland - consideration of no significance when mining was paramount.

As is well known, the southwestern part of Greenland is favoured by a comparatively mild climate. Ivigtut itself has an annual mean temperature of about $+1^{\circ}$ C., a January mean of about -7° C., and a July mean of about 10° C. Precipitation averages about 1,200 mm. per annum, perhaps the highest in Greenland. The climate is apparently subarctic rather than arctic. It is appreciably less maritime than stations on the outlying islands. The local vegetation cover is good grass and herbs, and low bushes, mainly of willow, which together give the area a most unarctic appearance in summer. Navigation conditions are among the best in Greenland. The ocean outside Arsuk Fjord does not freeze in winter, and although some ice forms in the fjord itself between late December and early April, the harbour can be used throughout the winter. Ivigtut is in the part of Greenland where ocean and air temperatures have become appreciably milder in the last 35 years. In summer, the heavy arctic pack-ice from the east Greenland coast swings northward around Cape Farewell and past the entrance to Arsuk Fjord. While it never penetrates the inner fjord itself, it may close the entrance for short periods. This has been relatively rare in recent years, although 1952 conditions were extremely difficult. On the whole, Ivigtut has a very good location from the viewpoint of shipping. This was recognized during the last war when Arsuk Fjord was a meeting place for some North Atlantic convoys. The inner part of the fjord provides excellent shelter, both for peace-time shipping and under war conditions.

There is then much to commend the suggestion that the Ivigtut settlement which has grown up during the past century, should be maintained and even expanded when the mine itself is exhausted. Stock-piles of cryolite will be sufficient to continue shipments for about a decade after actual mining ceases, so there should be time in which to adapt the settlement to new uses against the day when cryolite shipments cease. There seems little likelihood that other minerals will be found in the vicinity in sufficient quantities to justify continuing

operation of the settlement as a mining centre.[1] It seems probably that the nearby small Naval Station will need to be expanded as Denmark takes on greater responsibilities for the naval defence of Greenland and other operations in the North Atlantic. The fishing industry in west Greenland is expanding rapidly, both through the use of power vessels by Greenlanders, and through the visits of large fishing fleets from west European countries. Other shipping is also increasing. There is, at present, no ship-repair yard in southern Greenland, so the possibility arises of using the Ivigtut site for this purpose. The skills needed for such work are being developed gradually among young Greenlanders through training at the Holsteinsborg and Egedesminde boat yards, and by subsequent training in Denmark. When mining ceases at Ivigtut and the accommodation now needed for miners is freed, it could be taken over by skilled Greenland workers and their families. Eventually, a strong community of craftsmen could be assembled in association with the Naval Station nearby. While details of the lay-out for such a ship-repair yard are beyond the purposes of this paper, the intriguing possibility is suggested of using the large mine excavation itself as a well protected berth, with access through the narrow sea-wall.

While Ivigtut will remain in operation as a mining community for one or two more decades, it may eventually have the unusual distinction for a mining camp of continuing to be of service long after the mineral which brought it into existence is exhausted.

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[1] There are extensive deposits of iron ore at Grønnedal, but tests made a few years ago did not appear to justify operation of a mine. See Bøgvad, Richard. Nepheline, Syenite and Iron Ore Deposits in Greenland, Arctic, 3, 1950, p. 86-94.

EUROPE AND THE NEW CIVILIZATION

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The extent to which his environment influences man depends upon the nature of his civilization. Limitations or frustrations to one civilization may become opportunities or stimuli to another. It is the intention here to suggest that while Europe was geographically suited to the full flowering of an agricultural civilization, it is less suited than the large land masses for the full development of industrialization.

Geographically, Europe consists of the western extremities of the Eurasian continent, but it is a cultural rather than a geographical concept. Although bounded by seas and ocean on all sides but the east, its eastern limits have been cultural and have never long been stable. Not until Tsar Peter I of Russia began to 'westernize' his country at the close of the seventeenth century could the Urals be claimed as a boundary. Strahlenberg in 1730 was apparently the first geographer so to distinguish Europe from Asia and his Ural frontier was followed by the 'new' geographers of the nineteenth century.[1] But this Ural boundary is now quite unreal for the Ural mountains have been developed into an economic region of the Soviet Union closely related to the lands to both west and east, and they have ceased in any sense to be a frontier. Culturally, as Europeanization was destroyed in Russia by the liquidation of the westernized court and gentry in and after the revolution, the boundary of Europe could be said to have moved westwards to the Soviet frontier, and today, insofar as the elimination of western culture in the countries of eastern Europe is successful, the boundary of Europe lies even further west along the line of demarcation between Soviet and western influence - the "Iron Curtain".

Although Europe is not a continent in the literal sense of a self-contained land mass, it has a certain geographical individuality which consists basically in its kaleidoscopic structure pattern. As a result of pressures exerted upon it by movements of the three surrounding stable areas of Atlantis, African Gondwanaland, and the Russian platform, it has been highly folded and fragmented and sediments have been eroded from the raised portions to be deposited in the basins in such a way as to give, over short distances, a great variety of outcrop. From the alternation of resistant and less resistant, of permeable and impermeable rocks, arises a great diversity of soils, relief, drainage and vegetation typified in the Scarplands of France, Germany and England. Here is the essence of Europe.

An environment that favours the birth of a new civilization is not necessarily that which will promote its full development. Agricultural civilization arose in Asia Minor and Egypt favoured by the presence there of the wild

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[1] Philippson, A. Europa ausser Deutschland, Leipzig, 1928, p. 3.

ancestors of most of our present food plants and of the easily cultivated, annually renewed and very fertile alluvium of the great river valleys.[1]

Having originated at the eastern end of the Mediterranean, agriculture could expand in only one direction, to the west. On all other sides the ancient home of civilization was surrounded by desert and semi-arid steppe. But westwards, along the Mediterranean coasts and along the Danubian valley, precipitation increased, summer heat moderated and soils became more varied. For the ancient peoples this westward direction in which their merchants, colonists and fighting men were carrying civilization was 'Europe'; Greek mythology preserved the story of the King of Sidon who had two daughters, Asia and Europa; Asia stayed at home, but Europa was persuaded by Zeus, disguised as a bull, to accompany him to the island of Crete. Europe meant Crete and the other lands to the west and north-west.[2]

In Europe the possibilities for the new civilization widened. The great variety of soils, slope and climate fostered a wider diversity of food crops, of plant and animal fibres, of local habits and handicrafts. All of these contributed to the advance of civilization. Important in this advance was the ease of intercommunication which Europe offered to its peoples and their growing diversification of outlook and experience. There were few mountain barriers and the most impressive had low passes; there were no great swamps or impassable rivers, and above all, no deserts; the forests were the main obstacle, but as they were progressively cleared away, the isolated colonists met and coalesced into nations.[3]

Against this background, European culture developed its leading characteristics. The settled life lived in villages served by small market towns, administered and defended from small walled cities, forged a link between man and the soil which the former migratory civilizations had not permitted. Sedentary life and long winter evenings promoted handicrafts and arts, meditation and philosophy.

The geographical fragmentation of the continent promoted both nationalism and regionalism. While islands, peninsulas and other areas with natural boundaries tended to develop unity the broken structure within these units fostered regional separatism. Consequently the political history of most European states had as its theme a struggle between a centralizing monarchy aiming at supremacy within the natural borders and local independence. Both England and France possessed a large rich lowland area centrally placed which provided the resources for the reduction of outlying areas, and unity triumphed. But in

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[1] Peake, H.J.E. "The Beginnings of Agriculture", Early Man, London, 1931, pp. 94-125.

Scott Elliot, G.F. Prehistoric Man, Philadelphia, 1924, p. 217.

de la Blache, Vidal. La Personalité Géographique de la France, Manchester, 1946, p. 25.

[2] For a map of the westward advance of agricultural civilization, see de la Blache, Op. cit., p. 24.

[3] Bury, J.B. The Invasion of Europe by the Barbarians, London, 1928, pp. 10-15.

Spain, Italy and Germany local separatism proved the stronger.[1] This local separatism, in the temptation that it offered neighbouring states to enlarge their territories, was a chief cause of the continual warfare which became a leading feature of European life. Hostilities and feuds were inevitable within such a framework. Constant war, and threat of war, led to levies of money and men which brought about in turn, first the crystallization of a feudal aristocracy, and then the spread of some degree of centralized government.

Socially, the family flowered to perfection in Europe. The polygamy of nomadic peoples was abandoned; the jealousies of plural-wives, the rivalries of their sons, while relatively harmless with easily divisible flocks,[2] were less tolerable where farmhouse, implements and land formed the patrimony. A division of labour between the sexes arose: the woman in and about the house, the man in the field. Agriculture was a co-operative occupation which at times needed the united efforts of a whole family or even a whole village. Many sons and daughters, coming early in married life, were essential to take the load of labour from aging parents and to replace losses to the household from marriage and adventure, war and plague.

Christianity which, like agriculture, began in Asia Minor followed the new civilization into Europe, proving itself to be acceptable to communities based on agriculture.[3] The ideal of love and charity between neighbours was welcome where community of interests and the interdependence of the villagers was so strong. It gave the nascent arts a theme and purpose and it tended to confine savagery and hate to times of war.

Individuality was the keynote of the agricultural civilization of Europe – a pronounced national, regional and district personality. This is especially true of Hercynian Europe and most of all of the 'pays' of France.[4] Everywhere individualistic and local customs of growing and eating food, of making and wearing clothes, of building and heating homes, of transporting goods, reflected the characteristics of the ground beneath and the sky above. And just as Europe is unique in its multicoloured physical pattern, so European civilization developed as a mosaic of cultures, to which Greek philosophers, Roman governors,

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[1] "Das stark wechselnde Relief schuf weigehende örtliche Differenzierung. Die Erhebungszonen wurden durch die Waldnatur in ihrer grenzbildenden Wirkung nachhaltig verstärkt und haben darum zu einer kräftigeren Differenzierung landschaftlicher Lebensgemeinschaften gefuhrt, als es ihrer reinen Oberflächenformung entspricht" - Maull, Otto. Deutschland, Leipzig, 1933.

[2] As in Genesis, 30, 31.

[3] It would be less justifiable to draw an "Islam-nomad correlation". See Spate, O. H. K. "Toynbee and Huntington, A Study in Determinism", Geog. Jour. CXVIII, 1952, p. 417.

[4] "Partout, sur la peripherie des differents groupes - entre montagne et plaine, terres froides et terres chaudes, bocage et campagne, bon et mauvais pays - eclatent des contrastes dont s' est empare et qu' exprime avec surete le vocabulaire populaire" - de la Blache. Op. cit., p. 10.

Catholic fathers, feudal lords. Renaissance scholars, despotic monarchs, merchant princes and municipal burghers all contributed.

The boundaries of European culture have undergone many changes. With the growth of the Roman empire there was a premature expansion which embraced the whole Mediterranean world and extended to Britain and the Rhineland. Then came a period of prolonged attacks from nomadic pastoralists so that at one time the traditional Europe of Graeco-Roman culture and Christian religion was confined to an axis running from Britain through France and western Germany to Italy, hemmed in by hostile pagans in Spain as well as to the east. Medieval times saw the reconquest of Spain and the colonization of eastern Europe. Then came the great overseas expansion which made the littoral areas of all the continents tributary to Europe, to be followed by the contraction of European influence which we witness today.

Agricultural civilization began in Asia Minor but was perfected in Europe. Industrial civilization began in northwestern Europe. At the end of the eighteenth century, when the coalfields of England were becoming industrialized, Europeans had entered into trading relations with the littoral portion of most parts of the land hemisphere and Europe enjoyed a central position surrounded by potential markets. In northwestern Europe, where the textile industries based on agricultural products had long called for a population with manufacturing skills, water-power and the raw materials of early industry, fuel and iron, were found in many districts in small, but readily available, amounts. Agricultural poverty was an additional stimulus to early industry. Where soils were poor and farming possibilities were limited, men turned to manufacture to add to their resources. This was true not only of Pennine England and German Westphalia, but also of the early industrial areas of the eastern and western worlds: the Moscow area[1] and New England.[2] Large subterranean masses of coal or extensive but deep beds of phosphoric iron ore were of little significance for early industry compared with scattered deposits of coal and iron easily available at or near the surface. Continental locations far in the interior were at a disadvantage while good sea or inland waterway communications were important.[3]

Full-fledged industrialization implies the large-scale production of standardized articles for a mass-market. In this respect the European environment, so propitious to the old civilization built upon agriculture, is less favourable to the new civilization founded upon industry.

Against a background of structural complexity there have evolved in Europe a large number of sovereign nation-states, each deeply aware of its individuality and consciously distinguished from its neighbours by feelings of pride, fear and envy, by traditional enmity, ignorance and prejudice. These national divisions lie superimposed upon other divisions based upon physical characteristics, language, religion, or political philosophy. With the political divisions into states go economic divisions into currency and customs areas.

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[1] Baranski, N. Ekonomitchyeskaya Geografiya SSSR, Moscow, 1950, p. 54.

[2] Semple, E.C. and C.F. Jones. American History and its Geographic Conditions, Cambridge, Mass., 1933, p. 98.

[3] de la Blache, Vidal. Principes de Géographie Humaine, Paris, 1922, pp. 269-272.

Industrialization, needing a wide market for standardized products, finds in this continent of many small markets, each with strongly developed but differing tastes, little encouragement for its full-scale application. Not only do tastes differ from country to country, but from region to region; that a certain fashion prevails in one district may even make it unpopular in the next. The European tradition favours individuality and frowns upon standardization.

Furthermore, in Europe industrialization works against antipathies of another kind: feudal, aristocratic and Catholic. Deep in the European consciousness is a contempt for industrial work. The Soviet practice of 'honouring' workers appears ridiculous to peoples who still associate rank with landowning and birth. At the same time, many Europeans regard the high wages paid in America as improper. Such attitudes make it difficult to provide real incentives to production for the 'labouring population'. In the more conservative and Catholic parts of Europe, this uncongenial climate for industrialization is worsened by backwardness, a contentment with things as they are, a failure to appreciate mechanical devices, and a persistent belief in the superiority of nature. Generations of serfdom or attachment to the land have resulted in an excessive inbreeding in large sections of the population which fosters mental conservatism and hinders initiative.[1]

On the material side, the mineral resources of Europe, scattered and broken from a greatly disturbed geology, and often exhausted or exploited on a 'raubwirtschaft' basis, become less and less suited to modern requirements. As the demands of the steel industry for non-ferrous metals widen, as the importance of fissionable material grows, so the relative paucity of Europe's supplies of these elements increases. The subjugation of eastern Europe, with its carboniferous and metalliferous resources, to the power controlling one of the great land masses aggravates the situation for the western extremities at a time when they need most to utilize all their available wealth. Europe is dependent on imports of foodstuffs and raw materials, and as her colonies achieve independence, so the situation worsens.

North America and northern Eurasia provide a superior environment for the unfolding of modern civilization. A relative structural simplicity and late settlement have favoured the formation of large political units.[2] They also have linguistic simplicity. The three languages of North America contrast favourably with the 18 languages and many dialects of Europe. Throughout the Soviet Union there is but one language of higher administration and industrial direction although many local languages are encouraged for less important uses. With the large political and linguistic units go large economic units, free of currency control and tariff wall, and offering no barriers to mass production and standardization.

In the absence of physical and political fragmentation and in the presence of potent means of communication, regional traditionalism and particularism

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[1] For an interesting essay on this theme see Fleure, H.F. "Land Use and Liberty", Geography, XXXIII, 1948, espec. p. 172.

[2] Whereas the 27 states of Europe west of the Russian frontier contain under two million square miles, the three states of North American make up about 7½ million square miles, and the Soviet Union covers about 8 3/4 million square miles.

are relatively weak and dissolving before the virile new culture. The European desire to be distinctive is replaced, both in North America and in the Soviet Union, by a desire for social and political orthodoxy.[1] The result is a stereotyped material culture of standardized articles.

Against the conservative mental climate of Europe, is to be found in the U.S.A., Canada, and the U.S.S.R., a psychology which favours industrial development. The tradition is one of progress, of boldly adopting new ideas, of being the first to exploit new inventions, of pride in material progress. Size and speed, volume and performance, signify more than in Europe. The worker is no more regarded as inheriting the feudal inferiority of the serf, but his contribution is lauded and rewarded. In North America the industrial worker enjoys, in good times, a much higher standard of living than he could hope for in Europe. In the U.S.S.R., where consumer goods are few, the system of bonuses for high production enables the shock-worker or 'stakhanovite' to share them with the high official or the party boss.

On the material side, the extensive deposits of fuels, metals and other raw materials in Canada, U.S.A., U.S.S.R., and China, increasingly overshadow the diminishing European production. (Table I) Furthermore every new development in communications redounds to the advantage of the large unit.

TABLE I

Percentages of World Production of Coal and Steel for Europe, U.S.A. and U.S.S.R.

	Coal		Steel	
	1928	1950	1934	1953 [2]
Europe	45	30	45	28
U.S.A.	42	42	32	45
U.S.S.R.	3	19	12	20

The high speeds of jet propulsion, when fully applied to air transport, will improve intercommunications in large continental areas and place the small political units of Europe at a still greater disadvantage.

[1] The way for political orthodoxy in the U.S.S.R. was prepared by the Greek Orthodox Church which taught Russians to believe the same doctrine, not so much because the belief was true, as because Russians were one family and should share a common faith. Deviation was unfilial and disloyal. Compare the conception of 'un-American activity' in the U.S.A.

[2] These are "capacity" figures i.e., the amount that could be produced in 1953 if the available plant is fully utilized. They will probably be fairly close to the actual 1953 production figures as most steel plant is worked to capacity at the present time.

Both in North America and in northern Eurasia, the coming of industrialization was preceded by a conscious rejection of some of the aspects of Europeanization. The American Revolution gave to the U.S.A. the political and economic freedom essential to progress. In Canada, where the renunciation was made gradually, progress was delayed. The Russian rejection did not come until the Revolution of 1917 when the Europeanization, introduced by Tsar Peter, was swept away with the westernized nobility and 'bourgeois' class.

Although the U.S.S.R. turned her back on Europe much later than the U.S.A., the rejection was more complete. America meets with many problems caused by the persistence of some aspects of the former way of life. The Soviet Union is in many ways a more interesting example of industrialization because Europeanization had never gained a hold on the mass of the people, and the Russian reaction against western influences and ideas was clean-sweeping and thorough. Consequently, Russian industrialization is not inhibited by an anti-materialistic religion, by prejudice against State organization and monopoly, nor by political ideals of freedom and liberty, all of which North America has inherited from Europe and to some of which she holds even more tenaciously than Europe herself.

In the coming of Communism to China, with the anti-western policy of the new government of that country and the expulsion and persecution of foreigners, can be seen the latest repudiation of European influence by a large continental land area whose littoral was long the scene of western exploitation.

The industrialization of the land masses has had an important effect upon world trade. Commerce by sea, which developed so rapidly from the sixteenth century to the nineteenth, lined the coastal regions of the new lands to Europe and continental interiors were at a disadvantage. Now that the Europeanized littorals have turned their attention inwards to the development of their own vast hinterlands, their trade and intercourse with Europe diminish, and circulation within the land masses increases. Much existing European overseas trade stems from remnants of the colonial system.[1]

Self-sufficient in many respects, the large land areas of North America and northern Eurasia are more concerned with internal than maritime trade.[2] This generalization is truer of the U.S.S.R. than the U.S.A. where wasteful domestic consumption and rearmament on a huge scale hasten the exhaustion of many raw materials. Against this must be set the ability of American industry to synthesize.[3] The great sea-commerce that grew up in the prime of European

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[1] The true economic relationship between North America and western Europe is disguised by the large aid plans, such as the Marshall plan and military assistance. Without these, trans-Atlantic trade would have been greatly reduced in the post-war period.

[2] The large trade between U.S.A. and Canada, as well as that between Russia and China, are part of the growing internal trade of the continental areas.

[3] After the successful establishment of the synthetic rubber industry in U.S.A., plans are now proceeding for an oil-from-coal industry (hydrogenation) to insure against a future oil shortage. See The Economist, C LXI, 1951, p.1112.

civilization may have been a temporary phase resulting from the development of the outer fringes by Europeans.[1]

North America needs few of the goods of western Europe, the Soviet Union can do without them, and the smaller and more backward continental areas will not indefinitely need them. As the industrialization of the extra-European world increases, so it will cease to require European manufactures; as its population increases, so it will have a diminishing food surplus available for Europe.[2]

The supremacy of Europe and the importance of ocean transport are inseparable and the decline of one involves the decline of the other. Railways and roads began the economic development of continental interiors and air transport is now hastening it by providing a means of communication with all parts of an interior, however inaccessible to other forms of transport. This is illustrated in both the Canadian and the Soviet Arctic territory.

The most striking legacy of the period of European supremacy is seen in the great seaports which grew up for the exchange of colonial prime produce and European finished goods and which have concentrated roads and railways and amassed vast amounts of capital. Expressive of the changed situation is the removal of the capital of the Soviet Union from the seaport of Leningrad to internal Moscow, which can be likened in some respects to the removal of economic power from Wall Street to Detroit.[3] A city like Chicago is better suited to be the metropolis of the North American continent than New York as it is, like Moscow, a centre of internal communications. In both U.S.A. and U.S.S.R., the population centre moves steadily towards the interior.[4]

It is not difficult to understand why European nations have been accused of imperialism by both U.S.A. and U.S.S.R. in spite of their mutual antagonism and their own imperialist achievements in acquiring land from backward peoples. To them imperialism means European influence outside of Europe and to that both, looking back to great anti-European revolutions as the mainsprings of their greatness, are hostile.

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[1] If so, the St. Lawrence Seaway, as a seaway, though not as an inland waterway or a power project, comes a century too late. Once cannot help thinking back to the building of the New York Barge Canal at enormous cost and amid great enthusiasm. "No Jeremiah of 1900 could have foreseen the lamentable outcome of the state's huge expenditure". Semple and Jones. Op. cit., p. 279.

[2] For the decline in the trade of the Soviet bloc with the rest of the world, a fundamental of Soviet policy, see: "The Soviet Union since World War II", Annals of the Amer. Acad. of Pol. Sc., 1949, p. 88; also, World Economic Report, 1950-1951, United Nations, pp. 109-115.

[3] See The Economist, CLXVI, 1953, p. 80.

[4] Lorimer, Frank. The Population of the Soviet Union, Princeton University Press, 1946, pp. 145-164.

Baranski, N. Ekonomitcheskaya Geografiya SSSR, p. 16 and maps on p. 14.

See The Economist, CLXVI, 1953, p. 80.

A GLANCE AT THE AMU-DARIA AND THE ADJACENT COUNTRIES

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The ancient Oxus, Djihun of Arabian geographers, the Amu-Daria of today, begins in the Pamir Mountains and flows approximately 1,500 miles to enter the Aral Sea by means of a wide delta.

Two rivers, Pamir and Vahan-Daria, by joining on the border between Afghanistan and the U.S.S.R., give birth to Pyandzh River, which in turn after receiving a large tributary from the right, the Vaksh River, flows farther under the name of Amu-Daria. It is the fastest river in the U.S.S.R., having an average velocity of nearly 10 m.p.h. Its erosional force is extremely strong. During a calm, summer night, in many places along its banks, dull knocking, splashing, tremendous crashing and a roaring resembling thunder, may be heard. These are the waters of the meandering Oxus, washing away its banks and often gaining 20 to 25 inches of ground per hour. The natives call this erosional disaster - Degish. Long artificial levees were built to prevent Degish, but every year water destroyed them for a distance of two to three miles. The river moves to the right continually and without interruption. Between 1905 and 1915, Amu-Daria shifted two to three miles north-east below Turtkul. The city Petro-Aleksandrovsk, built in the 1870's, later called Turtkul, was situated three miles away from the river in 1888. In 1932 that distance had decreased to three-quarters of a mile. The very existence of the capital of Karakalpak A.S.S.R. was threatened. The struggle with the river was greatly complicated by depth of water, velocity of current and the impossibility of strengthening the easily eroded ground. Both cheap and expensive means were tried out in order to stop the destructive work of the river. However, none of them gave the expected results. Then, the city was simply left to the mercy of the elements. While leading a normal life, it lost its park and two adjoining sections in 1947. Today, Turtkul most probably exists only on maps. In its former position roar the waves of Amu-Daria. The capital of Karakalpak A.S.S.R. was transferred to Nukus, also situated on the Amu-Daria, but some 200 kilometres to the north-west.

The waters of this desert river are very changeable. Not only do they erode their banks, and obstruct navigable channels with mud, sometimes in the course of a few hours, but they also deposit large sandy islands, or suddenly change their bed. Once, in the first half of the Tertiary Period, the waters of pre-Amu-Daria flowed directly west, joining the waters of the Murgab and Tedzhen rivers, depositing sandy plains in the southern part of Kara Kum. As time went on, the river gradually changed its course to the north-west, till finally, during the period of greatest glaciation, its waters, after they left the mountains, flowed north, taking advantage of a part of the bed of the present day Zeravshan River. On the other hand the pre-Amu-Daria River turned westward again in its lower course, filling with its waters the valleys of Khiva, Sary-Kamyz and Assakeudan, changing them into one, large, fresh-water lake. From it began,

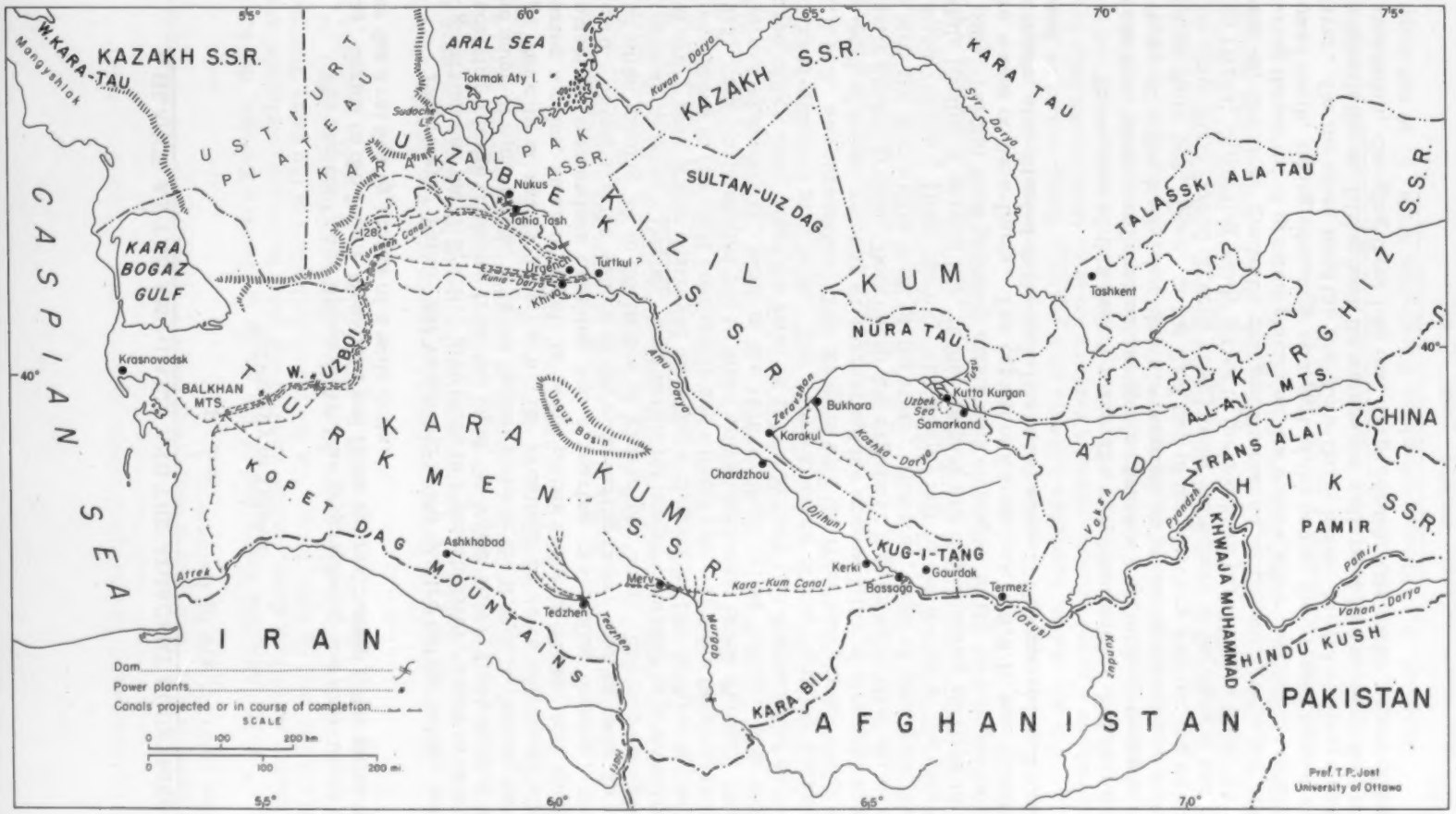
KAZAKH S.S.R.
W. KARA-TAU
Mangyshlak
CASPIAN SEA
USTYURT PLATEAU
KARA BOGAZ GULF
Krasnovodsk
BALKHAN MTS
W. UZBOI
ARAL SEA
Tokmak Aty I.
Sudoche Lake
KARAKALPAK A.S.S.R.
Nukus
Takhia Tash
Turkmen Canal
Urgench
Kunia - Darya
Khiva
Turtkul ?
Kuvan - Darya
KAZAKH S.S.R.
SULTAN-UIZ DAG
KARA TAU
Syr - Darya
TALASSKI ALA TAU
KIRGHIZ S.S.R.
KYZIL KUM
NURA TAU
Tashkent
Amu - Darya
Zeravshan
Bukhara
Uzbek Sea
Kutta Kurgan
Samarkand
KARA KUM
TURKMEN S.S.R.
Urguz Basin
Karakul
Kashka - Darya
Chardzhou
(Djikun)
KOPET DAG MOUNTAINS
Ashkhabad
Atrek
Meru
Tedzhen
Tedzhen
Murgab
Kara - Kum Canal
Kerki
Gourdak
Bassaga
KUG-I-TANG
Termez
(Oxus)
Kunduz
KARA BIL
AFGHANISTAN
IRAN
ALAI MTS.
TRANS ALAI
CHINA
TADZHIK S.S.R.
Vakhsh
Pyandzh
PAMIR
Pamir
Vahan - Darya
KHWAJA MUHAMMAD
HINDU KUSH
PAKISTAN
Dam
Power plants
Canals projected or in course of completion
SCALE
0 100 200 km
0 100 200 mi
55°
60°
65°
70°
75°
40°
Prof. T.P. Jost
University of Ottawa

Fig. I

and flowed southward, the Uzboi River in the direction of Caspian Sea. Nevertheless, it would be useless to search for that river today. Instead, there stretches a 700 miles long "Wadi", which in places is 180 feet deep. In the deep meanders of the Wadi, whose banks still show clearly traces of erosion, shine emerald lakes, in which glitter in the desert sun thousands of white crystals of gypsum, sometimes reaching eight inches in width.

Why did the Uzboi River disappear? Simply because the waters of Amu-Daria obstructed the whole Khiva Plain with mud. In its place, they formed an embankment of sediments, and turned northward toward the present day Aral Sea. Probably, this took place 300 to 400 years before our era, hence the Aral Sea, which until then was a small lake supplied by waters from Syr-Darya, is the only sea whose creation could have been observed by man.

The Amu-Daria is a desert river, separating two desert areas, known as Kara Kum (black sands) and Kizil Kum (red sands). However, we should not be misled by these names. The regions extending along both sides of Amu-Daria are not covered by sand dunes alone. A traveller, approaching the Amu-Daria along the eastern coast of the Aral Sea, meets hilly areas at the border of Kazakhstan. Their forms differ, because of the different rocks from which they were created. The rocks, resembling piles of cushions or pyramids, are simple weathered granites. Steeply dipping layers of quartzites form enormous combs. The gneiss produces forms resembling fences. From far away marbles look like ruins of cities, and clayish slates have rounded shapes and are densely cut by shallow canyons. In dales, at the foot of the rocks, springs often appear, having good fresh water and surrounded by bright green vegetation. This area of hilly, rocky half-desert is called Szoku by the Kazakhs. The typical hamadas, gloomy deserts strewn with stones and gravels, covered by black, shiny "desert laquer", may be found mainly in the central parts of Kizil Kum.

West of the mouth of Amu-Daria stretches a large plateau, Ustiurt, with an area of over 90,000 square miles. The western geographers misspell its name, writing it "Ust-Urt". This could easily mislead one because among different slavonic languages "Ust" means mouth and "Urt" could therefore be a proper name of a river. Yet there are no rivers with their mouths here. Thus the proper spelling is one word "Ustiurt", which comes from a Kazakh's word "Ystiurt" - meaning plain. This plateau built mainly from limestones is partly covered by a gypsum desert, so-called Kyr. A series of smaller kyrs surround Ustiurt occupying flat summits of isolated hills. Hence, some scientists apply the term kyr to certain forms of terrain resembling our buttes.

In the vicinity of rivers or of the Aral Sea, one can often find clay deserts called Takyrs; their soil is cracked because of drought and heat. These are the most lifeless types of deserts. The extensive area of the former Sarykamys lakes is covered by a salty desert known as Shor. The thickness of the salt layer there exceeds 20 feet in some places. There are other shors in Uzbekistan and Turkmenistan. However, they were not created in areas formerly occupied by lakes, but were formed because of the evaporation of ground water. This type of desert contains several kinds of salt, among which sodium sulphate prevails. Among the natives this type is known as "mellow shor", for the reason that under the layer of salt two millimetres thick, there is a "powder" layer, made up of dust and salt. The shors may be dry or damp,

muddy or covered by a crust under which there spreads quaggy slime. Where nature created clay hills, there form magnificent bad-lands. For example, in north-western Turkmenistan there are spots, where within the stretch of one mile, there are over 200 gullies. This type of desert area, often joined with takyr and shor, is called by the inhabitants Czel. The most useful for man, is the type of desert in south-western Asia, known as Adyr. This kind is found almost exclusively in river valleys, or at the border of steppe areas. It is very rare in the central parts of desert regions. During summer and winter, the Adyr is a true desert - flat and lifeless. However, in spring and often in autumn, when melting snow or rains supply the soil with water, it changes into boundless meadows covered with thick grass where thousands of tulips, poppies and other multi-coloured flowers grow. Areas covered with sand, are known here as Kum, which means sand, and the natives call them "kara" - black, or "kizil" - red, according to the colour which dominates in a given region. The most southern desert of the U.S.S.R. is known as Kara Kum. Its sands are not black in reality, but steel-greyish or blue-greyish. Their composition is very differentiated. We can find 41 other minerals besides quartz, such as mica, blende and feldspar, in the form of pink, green or yellow grains; crystals of garnets, tourmalines and several others. These are the youngest alluvial sands brought by the Amu-Daria. The shapes of their grains are polygonal, only slightly rounded by wind, from which dunes, embankments and hills are formed.

The sands of the Kizil Kum desert are entirely different. They stretch from the east, from the piedmont, loess desert, where Kashka Daria and Zeravshan rivers disappear, to the coast of the Aral Sea. Except that coast, where the Kizil Kum sands, washed by waters of Permian, Jurassic and Cretaceous seas are white and strongly cemented by silica forming a hard and pure sugar-like quartzite, the country is covered by bright orange, rusty-red, or brick-red sand dunes. These are the old sediments formed from weathered mountains extending into the central part of Kizil Kum. The main chain of these mountains which rise nearly 2,500 feet, is the westernmost ridge of Sultan-Uiz-Dag. The heights of central Kizil Kum, built from the same rocks as Tien-Shan Mountains and containing similar minerals to those of Mugodzhary Mountains, are named by Russian geologists Uralo-Tien-Shanid Mountains as belonging to the same mountain system.

Among the most interesting phenomena found in deserts surrounding Amu-Daria are what the natives call "Stony Chests", "Devil's Brushes", and "Stony Snow". At the foot of the Ustiurt plateau, mainly in its western part, one can find large, hard stones, empty inside with only a thin lining of dust and stony shell. It might be interesting to note that they were formed from rocks detached from the plateau which itself is made of considerably soft, limey sandstones and marl sandstones. Their formation is explained in the following way. The rocks absorb moisture during the melting of snow and rainy periods. The rays of the sun cause the water to evaporate quickly, thus bringing out the calcium carbonate dissolved in it to the surface of the rock. In the course of hundreds of years, a hard crust forms on the surface of the rock, under which there remains a mellow, clayish, matrixless dust. Should abrasion rub away part of the hard covering, or a crack appear, the wind blows out a mass of dust from inside leaving a "Stony Chest". In the central part of Kara Kum, in the clayish Unguz basin, "Devil's Brushes" can be observed. All of the clay

area is divided by deep crevasses into polygonal plates having a diameter of one to two yards. The earth's surface is absolutely clean. There is not even a single grain of dust or blade of grass. Only transparent, beautifully glittering crystals protrude four to eight inches from the ground. A process resembling that of the "Stony Chests" takes place here. The earth cracks from the great drought. Hot air penetrates crevasses and increases evaporation. Water contained in the rock moves toward the crevasses bringing and depositing dissolved salts. The clay forming the Unguz basin contains gypsum, and thus the cracks are mainly filled with gypsum crystals. The force of their formation is such that they gradually enlarge the crevasses by about three to four inches and, continually growing, finally emerge on the surface. There, owing to changes in temperature, they break into numerous fine plates, forming areas impassable to camel or horse without injury to their feet. They are truly "Devil's Brushes".

Sometimes, because of a similar process of evaporation of water, the gypsum is deposited not on the surface but four to six inches below. It exists there in the form of a white, shiny dust. The thin layer of soil is easily crushed by passing automobiles or feet of caravan animals. In such cases, the dust emerges on the surface, completely resembling snow. Naturally, it is not cold and does not melt. The Kazakhs call it Bozyngen meaning "stony snow". Such snow may be found in summer on the Ustiurt plateau.

The deserts stretching along both sides of the Amu-Daria, though often terrible and dangerous do not lack life. Man searches for ores and minerals, mining gypsum, potassium and magnesium salts, rock salt, sodium sulphate, graphite, boracite and borax in Kizil Kum; sulphur, alum, ozocerite and saltpetre in Kara Kum; and coal and manganese on the western borders of Ustiurt, on the Mangyshlak Peninsula and in western Kara-Tau Mountains.

Still unexploited are recently discovered reserves of coal, and potassium salts in the Kug-i-Tang range situated on the right bank of the Amu-Daria, in the region of Gaurdak; the layers of manganese, copper, oil, phosphorites, sulphates, different salts and chemically pure limestones in western Ustiurt.

In spite of the terrible Afgan wind, which carries clouds of dust and sand dimming the sun, and burning with its hot breath the leaves of plants, and which visits the area approximately 40 to 70 times a year, there still grow about 2,000 different kinds of grasses, bushes and trees. I have no intention of mentioning all of them here, but I should like to name a few characteristic ones, which supply food and fuel for nomads or those settled in an oasis, and which provide pasture for several kinds of animals. They are: wormwood, (Artemisia maritima incana) which loses its bitterness in autumn thus making very good and nourishing food for herds of sheep and camels; grass called Selin (Aristida) by Turkmen, of which even the thinnest roots are enclosed in a thick elastic tube, made up of sand glued together with plant juice, and supplying hay which constitutes a reserve in case of lack of pasture during winter. Finally, in the semi-desert regions of Turkmenistan, Uzbekistan and south-western Kazakhstan, there grows an unusually interesting plant called manna (Aspicilia esculenta). Curiously enough, it is capable of multiplication by pieces of broken epidermis. Such pieces are often carried by wind for great distances. If the rain falls or the wind ceases, manna drops to the ground.

True forests, consisting of trees and bushes, and known in Turkmenistan as Tokoj, stretch along the valleys of the Amu-Daria, Zaravshan, Murgab and others. In these gallery forests the dominant trees are: Tamarix, covered by pink flowers in spring; the igde tree (Eleagnus angustifolia) having sweet, starchy fruits, good for eating and better still for the making of alcohol; and others, commonly known, such as poplars, willows, elms, etc.

Considerably more interesting phenomena are the forests of sandy deserts - forests without trunks, leaves, needles and without shadow. One could add to this that the lumber from such forests cannot be floated, it cannot be used as a building material, it can neither be chopped nor sawn. These are forests consisting of the saksaul trees (Arthrophyton ammodendron), which is the best wood fuel of the world as its caloric value exceeds that of many kinds of brown coal. The saksaul tree has a massive, erect, underground trunk branching on the surface into spreading bush, having bent and split branches. Its bark differs from ordinary trees: its young have a greenish-yellow colouring with dark-grey stripes. It has no leaves; these have been replaced by a kind of young, green bud, at the tip of older, hard branches. The saksaul tree is so compact that it sinks in water, and in spite of its hardness it is very brittle, so that one does not saw it but breaks in into pieces. Besides this kind of saksaul, growing in the northern part of the discussed area, there exists another known as the "white saksaul", which grows in a thicket but is associated with acacia (Amodendron karelini) and other plants and is slightly higher than the former kind of saksaul (six to 15 feet). The third type is the "black saksaul". It grows on salty soils where ground waters are near the surface. It forms a separate "bush kingdom" of its own. The largest of these grows in the north-western part of Kizil Kum and is absolutely impassable. The saksaul buds provide excellent food for antelope, camels and sheep.

The irrigated desert regions often make excellent fields for cultivation and the U.S.S.R. has decided to build a number of canals which would cross the Kara Kum and Kizil Kum deserts. The water supply would come from Zeravshan and the mighty Amu-Daria. The latter in the vicinity of Chardzhou, carries over 900 cubic meters of water per second, during the period of low water, in November, and over 5,000 cubic meters per second in July, which is the high water period. In 1940, 100,000 kolhoz workers started the construction of the Kutta Kurgan basin, called the Uzbek Sea, in the region of Bukhara. In September 1950, the U.S.S.R. government approved the construction of the Turkmen Canal, 700 miles long. It will begin in Tahia Tash, and end in the vicinity of Krasnovodsk. It will irrigate western Kara Kum and the waterless areas of the Caspian plain. The canal should be finished in 1957. There is also a plan for building the Kara Kum Canal. It should begin in the locality of Bassaga in south-eastern Turkmenistan and lead through the Murgab and Tedzhen oasis to Askhabad. Its length will be approximately 520 miles. There is also a project for constructing a canal beginning near the town of Kerki and stretching north-west and north to join Zaravshan River some 280 miles from Amu-Daria. The third scheme involves the construction of a dam in the lower course of the Amu-Daria, and irrigation of the western part of the Khiva plain, where according to Russian specialists nearly 2,500,000 acres are suitable for cotton plantation. Finally, the fourth plan includes the building of a canal, 120 miles long, from the region of Khiva to the former bed of western Uzboi. The water of this canal will irrigate not only part of the Kara Kum desert, but also

the only tropical region of the Soviet Union. In this region there is no frost or snow, and one enormous garden of 1,500,000 acres could be created there, consisting of such trees as orange, lemon, tangerine, olive, pomegranate, and tea plantations.

All these projects are great and splendid and I believe that if the presen situation does not change they will be realized in the course of 10 to 20 years.

THE ROLE OF GEOGRAPHY IN MILITARY PLANNING

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To many geographers, military geography is an imprecise term. Today, this aspect of geography is thought of as the relationship of geography to military science; the relationship of some, or the total of all the environmental factors such as relief, climate and weather, vegetation, soils, lithology, drainage characteristics, and cultural features - to the solution of military tactical and strategic problems.[1] The existence of such a relationship is not new. The elements of the environment have played important roles in all wars from those in which the stone hammer was the principal weapon down to the present time. However, the existence of a consciousness of such a relationship by the military planner dates only from the First World War. This concept of military geography was long prominent in German military thought. The Germans were the first to recognize the usefulness of geography and the natural sciences and to realize their contribution to military intelligence. A course in terrain analysis was given to German soldiers of all ranks. Nowadays, all military planners take cognizance of the military implication of the terrain elements as an integral function of effective military planning, both tactical and strategic.

The essential difference between the requirement of geography in tactical planning and strategic planning is similar to the same difference that exists between mapping areal categories on large-scale maps and mapping areal categories on small-scale maps. The mapper's requirement in presenting information on maps at different scales is determined by his objective. Similarly, the objectives of the tactical planner differ from those of the strategic planner.

The tactical planner is concerned with military problems within a small area. In a battalion command the dimensions of the area of interest may be one-half mile wide and one to two miles deep, whereas in a corps command the area may be 25 miles wide and 50 miles deep. Hence, the requirement of the tactical planner is one of quantitative detail relevant to the problem. If the objective of the tactical planner is to determine the suitability of a small area for movement by a certain type of army vehicle, he will be interested in a specific phase of a soil type that may affect movement by that vehicle. The tactical planner and the geographer both realize that such quantitative details can be only presented on large-scale maps ranging in scale from 1:5,000 to 1:100,000.

The circumstances surrounding the strategic planner differ greatly from those of tactical planning. The area with which the strategic planner is concerned may be global in size or that of a continent or country. The strategic planner's global approach is a function of a geographer's training and both realize that only small-scale maps can adequately show areal patterns for such

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[1] See: Falls, Cyril. "Geography and War Strategy", Geog. Jour., 112, 1949, pp. 4-17.

large areas. Significant qualitative generalizations are the requirement of the strategic planner and these can be only displayed on maps whose scale is smaller than 1:100,000. Such detailed aspects as a soil phase, although relevant to the tactical planner, may not be significant to the strategic planner.

GEOGRAPHY AND TACTICAL PLANNING[1]

The objectives of tactical planning that are affected by the elemental factors are related to movement, defences, artillery and supply in forward areas. The tactical planner's requirement is an evaluation of the terrain elements in terms of a military problem that may exist in the very near future or, if the line of battle is not fluid, for a present situation. The time factor will often ascertain the degree of interpretation that is possible. In a fluid battle situation, the geographer, employed as an intelligence officer, must provide the planner with the military evaluation in the shortest possible time. He will utilize every research source and method at his disposal - personal knowledge, literature, published maps, ground and aerial photographs, to provide a verbal or written evaluation. If the line of battle is stationary, a detailed analysis of the relevant factors may be possible and, if required, military evaluation maps may be prepared for the tactical planner.

What are some of the aspects of the various environmental factors that must be evaluated for all forms of tactical operations - ground surface, amphibious, and aerial operations?

Since modern warfare is basically a series of manoeuvres upon parts of the earth's surface, an obvious element affecting all forms of tactical operations are landforms and their resultant relief.[2] Ground operations are related to heights of land, commanding positions and the slope of the ground. However, the introduction of modern weapons such as the fighter-bomber and cruiser tank have reduced the military significance of many such landform features because of their susceptibility to aerial observation. Nevertheless, any ground-surface operation requires the evaluation of landforms in terms of movement. Slopes on certain landforms prohibit movement by certain types of motorized equipment and certain slopes may even form natural obstacles to all forms of movement.

Amphibious operations require the analysis of coastal landforms such as beaches and the landforms behind the beach area which could prevent easy access inland away from the beach or provide commanding artillery positions to the defender. In the Normandy invasion in June 1944, cliffs at each end of the beach provided the Germans with artillery positions which enabled them to slow up the Allied landings and advance inland.[3]

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[1] See also: Uren, P. The Status of Military Geography in Canada, The Canadian Geographer, 1, 1951, p. 13.

[2] See: Bryan, Kirk. "The Role of Physiography in Military Operations", Scientific Monthly, 11, 1920, pp. 385-403.

[3] Davies, Arthur. "Geographical Factors in the Invasion and Battle of Normandy", Geog. Rev., 36, 1946, p. 620.

Landforms also are of great significance to tactical aerial operations. They can determine local flying conditions and facilitate or prohibit air-drop operations.

The tactical planner's requirement for an interpretation of vegetation, whether it is in terms of movement by foot-soldiers or wheeled or tracked vehicles, concealment, construction, fuel, or food, can be met if the type, size, density and distribution of the vegetation are known. Movement by foot-soldiers or vehicles may be facilitated or impeded by the size, density, and wood-strength of trees. Closely spaced trees, such as are found in the Reichwald west of the Rhine, prevent tank movement.

The increased use of aerial observation during the Second World War emphasized the increased use of vegetation for concealment purposes. During the period before the invasion of Normandy, the trees, heath and scrub of Hampshire and Dorset effectively concealed evidence of pre-invasion activity and protected the troops from air attack. In Normany, the Germans utilized the bocage, small fields, separated by tree hedges based in thick earth banks, or by stone walls, to conceal their defence positions and probably reduced the effectiveness of the Allied air attack by 75 per cent or more.[1]

Soils are another important element that affect various military activities. The determination of the bearing-capacity of soils for troop and vehicle movement, the selection of locations so as to avoid unstable soils or areas susceptible to washouts or landslides, and the locating of sources of subgrade material, are some of the military problems related to soils. Knowing the dominant soils group of an area is not adequate knowledge for the problems of the tactical planner. The fact that a certain soil is a brown podzol takes on greater significance when the nature of the parent material or mode of origin and its position in the landscape are known. The military engineer makes practical use of the soil information and the military geographer frequently has to convert pedological units to engineering units based on the physical characteristics of the soil such as texture, structure or moisture content.

It is difficult to imagine any form of military operation that is not affected by some aspect of climate and weather. Any one of the countless climatic processes can seriously result in the success or failure of a tactical operation. Ground operations concerned with movement, construction or shelter can be affected by temperature, precipitation, floods, visibility and dry and wet periods. Thunderstorms changed the fine limon and clays to a pasty clay and made tank movement impossible during a certain phase of the Normandy invasion. Amphibious operations require an analysis of such phenomena as the degree of cloudiness, fog, temperature, winds, ice conditions and the temperature of the water. Similarly, tactical aerial operations require the interpretation of air turbulence, visibility, dust, fog, haze, winds at ground level and aloft, in terms of low-level flying.

Certain tactical situations require a knowledge of the lithology of an area.[2] The structure and texture of the available rock determines its suitability for construction and foundation materials for roads, airfields, tunnels and

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[1] Ibid., p. 621.

[2] See: Price, P.H. and H.P. Woodward. "Geology and War", Bull. Amer. Ass. Pet. Geol., 26, 1942, pp. 1832-1838.

large works whose locations and design depend upon the physical properties of the bedrock. In some localities, the only sources of potable water may be available only in a particular rock formation.

Drainage characteristics are of great tactical importance. Wide, deep rivers whose valleys offer concealment may provide satisfactory tactical defence or an effective barrier to offensive movement. Marsh and boglands favour defences but are unsuitable to cross-country movement. Areas susceptible to flooding such as polder land are significant to the tactical planner,

In addition to the natural elements that have military significance, many man-made features occurring on the landscape are relevant to tactical planning and must be interpreted in terms of the objective. Certain cultural features such as nucleated settlements, cemeteries, stone fences, road nets are as relevant to certain ground-surface operations as are many of the natural factors. The closely spaced villages of Western Europe provided the Germans with excellent defence sites that could be defended by a small force of infantry, artillery and a few tanks.

GEOGRAPHY AND STRATEGIC PLANNING

Today more than ever, the strategic planner must look at the world as a whole. He is the professional soldier, at staff level, concerned with the planning of possible military activity upon various parts of the earth's surface. The problems that the strategic planner may be concerned with include the interpretation of the terrain for movement and disposition of troops and motorized equipment over known or unknown areas; the selection of testing and training areas so as duplicate conditions of anticipated campaigns; the interpretation of terrain elements in terms of living conditions, clothing requirements and occupation; and the appraisal of sites for roads, airfields and other semi-permanent installations.

Because the objectives of strategic planning are concerned with problems over large parts of the globe, the knowledge, approach and methods of geography are closely related to the needs of the military strategist. Such planning requires the visualization of the globe as a mozaic of military regions within which the terrain elements are reasonably homogeneous or have similar diversification of environmental factors relevant to the military problem under consideration. The only cartographical method that can show the areal pattern of the relevant elements that are of concern to the strategic planner is the small-scale map. The map-scale, whether it is 1:100,000 or 1:1,000,000 or smaller must necessarily preclude the presentation of many aspects of the environment that are considered relevant by the tactical planner. All the relevant environmental factors and their ramifications that may occur within an area of 250 square miles must be contained within one square inch on the Millionth map. Therefore, only the most relevant or combinations of two or more of the more relevant factors can be considered by the strategic planner.

Geographers know that the earth is something about which we know very little. Only a small part of the land surface of the globe is covered by instrumental surveys. The selection of the significant military factor or factors in those little-known areas of the globe is an appreciable problem for the military geographer concerned with strategic planning.

SOME ASPECTS OF THE POLITICAL GEOGRAPHY OF THE DISTRICT OF KEEWATIN

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When the Dominion of Canada came into being in 1867 the Federal Government was faced with a number of problems in the internal political geography of the new state. Among these problems was that of the northern and western limits of the new Province of Ontario. The Constitutional Act of 1791 had defined Upper Canada as including "the utmost extent of the country commonly called or known by the name of Canada" and later official documents had used similar phraseology. As a result, it was claimed by some that Ontario, as a resurrected Upper Canada, extended to the Rocky Mountains on the west and the Arctic on the north and northwest. The solution to the problem involved the exact limits of the territory controlled by the Hudson's Bay Company and therefore little could be done until this territory was transferred to the Government of Canada in 1869. But almost immediately, in 1870, the Province of Manitoba was created. It was bounded on the north by the parallel of 50° 30' N. and on the east by the 96th meridian west[1] and efforts were then directed to finding a suitable western boundary for Ontario east of these limits. This depended upon the interpretation of various Acts of Parliament, Royal Proclamations and Commissions since 1763. Ontario took the view that the boundary should be a due north line from the source of the Mississippi River, approximately 95° 14' W. This was based on Sir Guy Carleton's commission as the Governor of Quebec, issued a few months after the Quebec Act of 1774, which described his government as extending from the confluence of the Ohio and Mississippi "northward along the eastern bank of the said river (Mississippi) to the southern boundary" of the Hudson's Bay Company's territories. Canada, on the other hand, defined this eastern boundary as the prolongation of a due north line from the confluence of the Ohio and Mississippi. This was based on the phrase in the Quebec Act of 1774 which defined the boundary of the then Quebec as following the bank of the Ohio River "Westward, to the Banks of the Mississippi, and Northward to the Southern Boundary of the Territory granted to the Merchants Adventurers of England, trading to Hudson's Bay".[2] By this interpretation the boundary would be in approximate longitude 89° 9' W. The country between this meridian and that claimed by Ontario, about 275 miles in width from east to west, became known as "The Disputed Territory".

In 1874, pending settlement of the dispute, Canada and Ontario agreed to a provisional conventional boundary which ran due north from the International Boundary through the most easterly point of Hunter's Island to the 51st parallel of latitude and then easterly along that parallel.[3]

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[1] Statutes of Canada, 33 Vict., Cap. 3, 1870.

[2] Shortt, A. and A.G. Doughty. Documents relating to the Constitutional History of Canada 1759-1791, King's Printer, Ottawa, 1918, p. 571.

[3] Statutes, Documents and Papers bearing on the discussion respecting the Northern and Western boundaries of the Province of Ontario, etc., Hunter, Rose and Co., Toronto, 1878, p. 347.

Before a final decision was reached on these boundaries of Ontario, settlers moved into the area northwest of them. During the October of 1875 a colony of some 300 Icelanders had settled on the west side of Lake Winnipeg in the neighbourhood of the present Ames and Riverton and on Hecla Island. The original colony was reinforced by some 1,200 additional settlers who arrived in the summer of 1876. The settlement extended from Boundary Creek, on the south, to Icelandic River on the north and its greatest inland depth was 11 miles.[1] It started its own system of self-government, founding the "republic" of New Iceland, but no formal machinery existed by which their affairs could be fitted into the Government of Canada. This became an immediate necessity when serious epidemic of smallpox broke out among them and spread among the Indians in the vicinity.[2]

THE CREATION OF THE DISTRICT

Therefore, in order to provide for the Government of this general area west of Ontario some 395,000 square miles of the Northwest Territories was set apart as a separate district on October 7, 1876, by virtue of the proclamation of the Keewatin Act.[3] The Act began with the words "Whereas it is expedient, pending the settlement of the western boundary of Ontario, to create a separate Territory of the Eastern part of the Northwest Territories ...". It was thus clearly intended to be temporary in character and its purpose was to give good government to the area east of Manitoba and west of Ontario. The district was to extend from the international boundary with the United States to the "northerly limits of Canada". Its western boundary was to follow the eastern and northern boundaries of Manitoba to the westerly shore of Lake Manitoba; thence northerly along the western shore of the lake to "Meadow Portage"; along this portage to the easterly shore of Lake Winnipegosis; along this shore to "Cedar" or "Mossy" Portage; along this portage to the shore of Cedar Lake and thence northward. Its eastern boundary followed the western shore of Hudson's Bay to the point where it would be intersected by the western boundary of Ontario which would be coincident with the remainder of the eastern boundary of Keewatin. The temporary nature of the Act was further emphasized by the proviso that the Governor-in-Council could, by proclamation, detach any portion of Keewatin and reannex it to the remainder of the Northwest Territories.

THE PRECISE LIMITS

It will be noted that Keewatin was to extend to "the northerly limits of Canada". These limits again depended on a precise definition of the territory formerly controlled by the Hudson's Bay Company. That doubt must have existed as to what the northern limits of this territory were, became apparent in 1878 when the Canadian Parliament, in an address to the Crown, requested a definition of the northeasterly, northerly and northwesterly boundaries of Canada.

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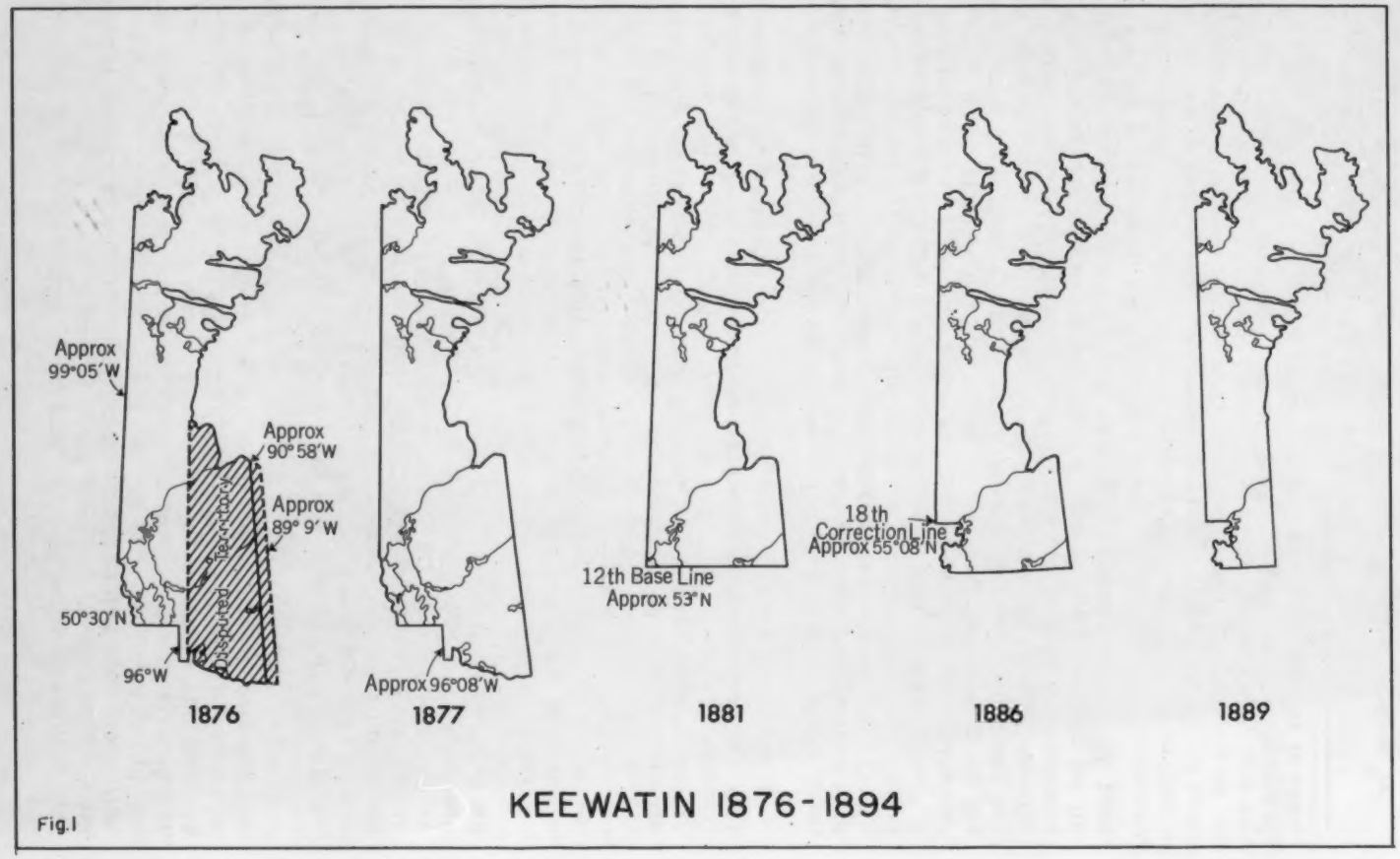
[1] Laxdal, Jon K. New Iceland 1875-1950, The Icelandic Canadian, 9, 1950, p. 17.

[2] Annual Report for 1877, Dept. of Interior, Ottawa, 1878, p. viii.

[3] Statutes of Canada, 39 Vict., Cap. 21, 1876.



KEEWATIN 1876-1894

Fig.1

This resulted in an Imperial Order in Council, in 1880, which stated that "... all British territories and possessions in North America, not already included within the Dominion of Canada, and all islands adjacent to any of such territories or possessions, shall (with the exception of the Colony of Newfoundland and its dependencies) become and be annexed to and form part of the said Dominion of Canada ...". This is generally taken to be the legal instrument by which Canada acquired the Arctic Islands. It would therefore seem that in 1876, when the Keewatin Act was passed, Canada did not include these islands and consequently Keewatin did not extend north of the mainland.

It is also clear from the terminology of the Keewatin Act that despite the "disputed Territory", the westerly boundary of Ontario and hence the easterly boundary of Keewatin should be far enough east that its extension northward would intersect the western shore of Hudson Bay. This meant that it would have to be east of about longitude 94° 45' W. Since the provisional western boundary of Ontario was the longitude of the most easterly point of Hunter's Island (90° 58' W.) when the District of Keewatin was erected, this must also have been the eastern boundary of Keewatin in 1876.

ADJUSTMENTS WITH MANITOBA

In 1877, the boundaries of Manitoba were redescribed so as to conform to the survey lines of the Dominion Lands System.[1] They were not very different from the boundaries of 1870, but as Manitoba's eastern boundary was moved west about five miles the result, as far as Keewatin was concerned, was that she gained a small strip of territory.

Immigrants continued to move into Western Canada and particularly those areas about Lakes Winnipeg and Manitoba. They soon alleged inconveniences in having their municipal and educational affairs governed by the laws of the Territorial and District Governments and expressed a desire to be incorporated in the Province of Manitoba which, it was contended, was "too circumscribed".[2] In 1881, the boundaries of Manitoba were therefore extended by Act of Parliament.[3] On the north they became the centre of the road allowance along the twelfth base line of the Dominion Land Survey System while on the east, they became "the easterly limit of the District of Keewatin ... that is, the westerly boundary of the Province of Ontario". Consequently the area of Keewatin was reduced. It no longer extended as far south as the International boundary for its southern limit was now the centre of the road allowance along the twelfth base line of the Dominion Land Survey System.

LOSSES TO THE NORTHWEST TERRITORIES

The continued increase in settlement, accelerated by the construction of the Canadian Pacific Railway, led to further political adjustments for in 1882,

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1 Statutes of Canada, 40 Vict., Cap. 6, 1877.

2 Annual Report for 1880, Dept. of the Interior, Ottawa, 1881, p. iv.

3 Statutes of Canada, 44 Vict., Cap. 14, 1881.

for federal administrative and postal purposes, four provisional districts - Assiniboia, Saskatchewan, Athabaska and Alberta, were created by Order in Council. The boundaries of Saskatchewan, on the east, were the western shores of Lake Winnipeg and the Nelson River and on the north the eighteenth correction line of the Dominion Land Survey System. These boundaries, like those of the Manitoba of 1881, also overlapped those assigned to the District of Keewatin in 1876. The intention was probably to include the settlements which had sprung up in the "overlapping portion" in the provisional district of Saskatchewan because they were economically and socially akin to the other settlements in that district rather than Keewatin. However, the discrepancy between the boundaries of Saskatchewan and Keewatin was not set right until 1886 when, by an Order in Council, the "overlapping portion of territory", that is, the part of Keewatin lying between Manitoba and the eighteenth correction line and west of the Nelson River, was reannexed to the Northwest Territories in order to become properly a part of Saskatchewan.

DILEMMA

The northern and western boundaries of the Province of Ontario were settled legally in 1889.[1] They were to run north from the northwest angle of Lake of the Woods to the middle of the Winnipeg River, along that river and English River to the head of Lac Seul, thence by a straight line to Lake Joseph through that lake to its "foot" and thence along the Albany River to James Bay. It will be recalled that under the Act of 1876, the District of Keewatin was limited to the territory lying west of a line running north from the western boundary of the Province of Ontario. There were two ways of interpreting this. If the whole of the newly determined boundaries of Ontario were considered as one, that is one westerly boundary, then Keewatin extended as far east as the mouth of the Albany River. This view was taken by some.[2] It was, however, a minority opinion for it seems to have been generally assumed that as a result of the Ontario boundary legislation, the District of Keewatin was confined to the area west of the longitude of the northwest angle of Lake of the Woods. It should be pointed out, however, that after 1889, the line running northward from the Lake of the Woods was so far to the west that it could not intersect Hudson Bay, as the Keewatin Act had decreed. Thus the true limits of Keewatin in 1889 can only be a matter of conjecture even if the Manitoba Act of 1881 and the Canada (Ontario) Boundary Act of 1889 together are regarded as superseding the Keewatin Act.

However, it was the popular view that there was a large land area north of Ontario, east of Keewatin and south of Hudson Bay which remained part of the Northwest Territories. The Lieutenant-Governor of Keewatin recommended the addition of this area to Keewatin since it was only easily accessible through Hudson Strait or by the rivers which flowed into Lake Winnipeg and could, therefore, be governed effectively only in the manner in which the District of Keewatin was governed. The Federal Government considered a proposal that the Keewatin suggested by the Lieutenant-Governor be limited on the north by Lake

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[1] Statutes of the United Kingdom, 52-53 Vict., Cap. 28, 1889.

[2] Debates, House of Commons of Canada, June 22, 1892.

Winnipeg and the Churchill River. This would have resulted in a political area within which the greater part of the population then in Keewatin was to be found, and which could be administered with convenience from Winnipeg because of the comparative facility with which it could be reached by water from that point through the Red River and Lake Winnipeg and its tributaries. This takes on additional meaning when it is remembered that the Lieutenant Governor of Keewatin was also the Lieutenant Governor of Manitoba.

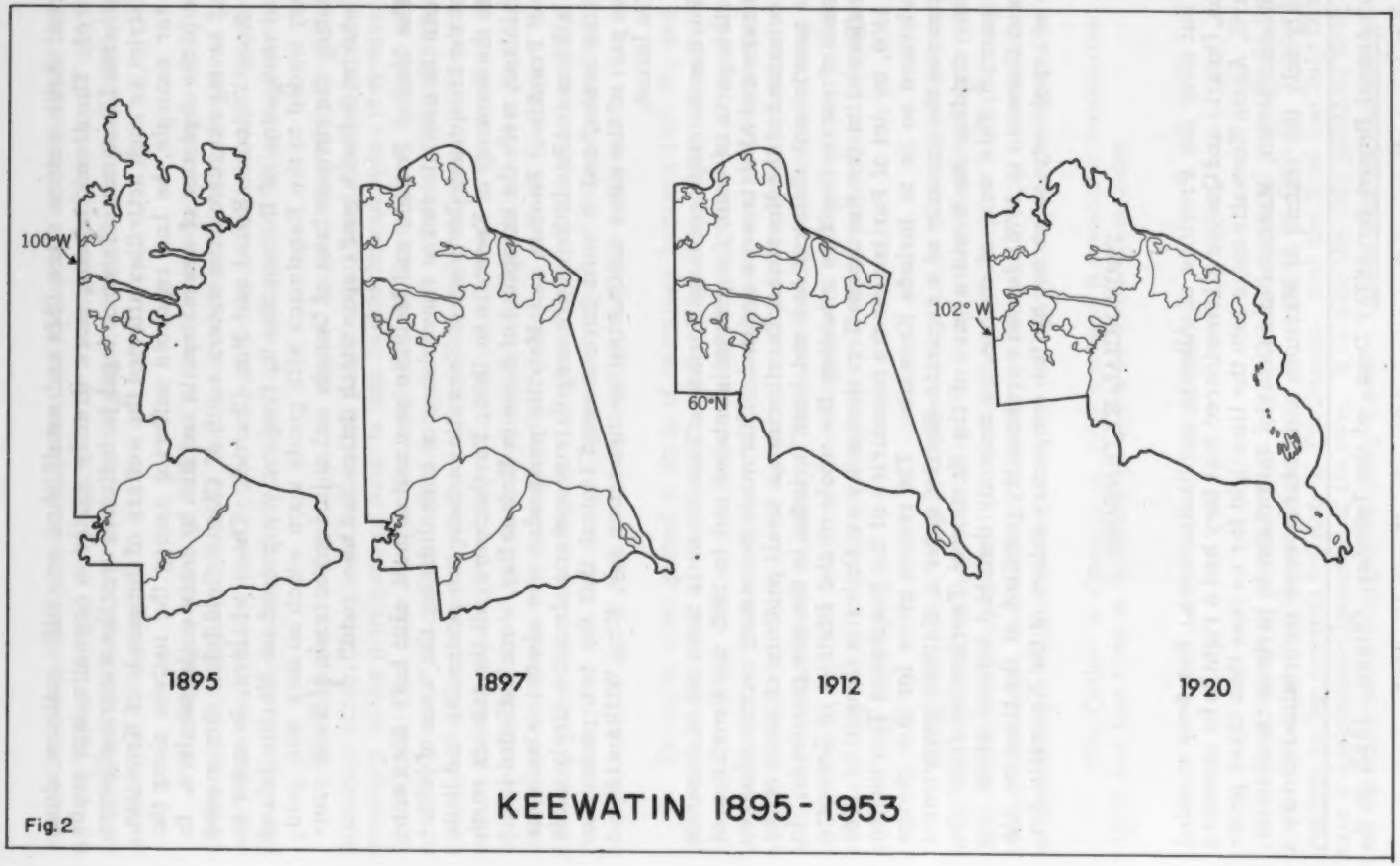
However, the boundaries of Keewatin according to this proposal would have been rather irregular and involved a lengthy description and because of this a third proposal, that the 99th meridian west be the western boundary instead of the longitude of the Mossy Portage meridian was considered. Another proposal for the western boundary was that it should be the 2nd meridian of the Dominion Lands Survey System, 102° W. On the east, it was suggested that the boundary should be the prolongation, due north, of the dividing line between Ontario and Quebec.

TERRITORIAL GAINS

The ultimate recommendation chose a western boundary between the 2nd meridian and 99° W. - namely 100° W. and included the area between Hudson Bay and the northerly boundary of Ontario in Keewatin. Actually this meant very little change in the western boundary of Keewatin as Mossy Portage is in longitude approximately 99° 05' W.

An Order in Council of 1895 included the recommendation that these changes be made in the area of Keewatin by Act of Parliament. The recommendation was also much more precise with regard to the northern limits of the district than had hitherto been the case. It will be recalled that the Keewatin Act of 1876 had merely stated that Keewatin extended to the "northerly limits of Canada". But in 1880 Great Britain had legally transferred whatever other territorial possessions she had in the Far North to Canada, and the Order in Council of 1895 recommended that Keewatin's northern and eastern boundaries follow the continental coast from 100° W. to the Albany River. It thus included Boothia and Melville Peninsulas in the District. But this Order in Council was deficient in some respects which did not directly concern Keewatin. Indirectly, however, they did affect Keewatin for another Order in Council was passed two years later which, in correcting these deficiencies, changed Keewatin's boundaries once again. By these changes Keewatin lost Boothia and Melville Peninsulas but gained most of Hudson Bay and its islands and certain water areas in Queen Maud Gulf, Rae Strait and the Gulf of Boothia. In 1895 the islands in Hudson Bay which were farther than three nautical miles from the coast had been excluded deliberately from any provisional district, but in 1897 they were just as deliberately divided between Keewatin and Ungava.

The reasons for the inclusion of most of Hudson Bay within the District of Keewatin were two-fold but by no means unrelated to one another. There was first of all the desire to ensure that Hudson Bay and Strait would be considered as an integral part of Canadian territory and not as international waters. This was a logical outcome of the Government expeditions which had navigated



KEEWATIN 1895 - 1953

Fig. 2

and charted these waters since 1884 and established scientific stations along their shores. The second reason, more directly related to Keewatin, was probably to give the Lieutenant-Governor legal jurisdiction over the waters adjacent to his District as such activities affected the welfare of the people of Keewatin. In 1890, for example, he had reported suffering among the natives along the coast due to the depletion of sea mammals and fish by commercial whalers. In that year, having exhausted the waters south of Chesterfield Inlet, they moved north to Roes Welcome Sound and Fox Channel. These whalers, in order to avoid late navigation of Hudson Strait, frequently wintered on Marble Island where they traded to the Esquimaux with goods upon which no duty was paid, thus violating the revenue laws of Canada and injuring the trade of those companies "who traded with goods upon which duties had been paid".[1]

The loss of Boothia and Melville peninsulas must also have been concerned with the administrative convenience of consolidating the area of jurisdiction of the Lieutenant-Governor of Keewatin as these two peninsulas had little to do with the economy of Keewatin in 1895. Furthermore, all the islands north of the mainland, with the exception of those in Hudson Bay, were included in the District of Franklin. Boothia and Melville peninsulas are almost islands for Boothia Isthmus and Rae Isthmus are very narrow and are almost entirely made up of water areas, and it must have seemed logical that the two peninsulas should be part of the same administrative district as say, King William Island and Baffin Island.

Further development in the Northwest Territories in time led to demands from certain parts of them for provincial status and in 1905 the Provinces of Saskatchewan and Alberta were created. This made necessary certain changes in what remained of the Northwest Territories as small portions of some of the previous provisional districts had not been included in the new provinces. In the process of correcting this situation the whole of the District of Keewatin was transferred to the Northwest Territories by an Order in Council of 1905 and, in 1906, by Act of Parliament the boundaries of the Northwest Territories were redefined so as to include Keewatin. The reason given for this change was to remove the anomaly of a separate district under a distinct government completely dividing the western part of the Northwest Territories from the eastern part.[2] This was, of course, an anomaly that had existed since the creation of Keewatin in 1876, but was presumably justified at the time on the grounds of expediency as shown by the temporary nature of the Keewatin Act.

PROVINCIAL EXTENSIONS

But after the Province of Alberta and Saskatchewan had been created Manitoba, Ontario and Quebec all considered that they had a right to be extended northward. Again Keewatin came into the limelight for no less than three provinces, Saskatchewan, Manitoba and Ontario, laid claim to parts of the district. Ultimately only the claims of Manitoba and Ontario were entertained and as a

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[1] Annual Report for 1891, Dept. of the Interior, Ottawa, 1892, p. 4.

[2] Debates, House of Commons of Canada, March 19, 1906.

result the continental portion of Keewatin was limited on the south to the parallel 60° N. These changes were approved by a resolution of the House of Commons in 1908 but the boundary extension legislation insofar as it affected the provinces, was not passed until 1912.

The changes which it affected in the Territories were the subject of an Order in Council passed in 1918, but to take effect in 1920. As far as Keewatin was concerned, it lost the areas incorporated into Manitoba and Ontario so that the southern land boundary of the District became the 60th parallel of latitude.

There seems to have been no reason for choosing this as the southern boundary other than the fact that that parallel had been chosen as the northern boundary of the provinces of Alberta and Saskatchewan when they were created in 1905. At that time, it was the opinion of the Government that the area north of 60° N. was "absolutely unfit for agriculture" and that although it had indications of mineral wealth, there was little hope of "thick and permanent settlement" and consequently stable provincial government.[1] The southern boundary of Keewatin had to be north of the latitude of Churchill however as it was the desire of the Government to give that potential port to Manitoba. However, Keewatin gained the eastern part of Hudson Bay and its islands. This was all that remained of the District of Ungava after Quebec's boundaries had been extended in 1912, and it was obviously logical to add it to Keewatin.

Keewatin also gained a strip of territory between 100° W. and 102° W. (the second meridian of the Dominion Lands System). The writer can find no reason for adding this area to Keewatin but he suggests that it may have been the result of two factors. First of all the addition meant that the western boundary of the district was moved westward so that it became a continuation of the Manitoba-Saskatchewan boundary. This undoubtedly resulted in a "neat looking" political map and the Government cartographers of the time were always conscious of the overall "look" of the map of Canada, superficial though such an attitude may have been.

But 102° W. also roughly divided those areas of continental Canada north of 60° N. which were approached by the Hudson Bay-Hudson Strait route from those which were approached via the Mackenzie River and its tributaries. In this sense, therefore, the western boundary of Keewatin may have been chosen as an approximate watershed boundary, in the light of maps existing at that time.

The Order in Council of 1918 changed Keewatin's boundaries for the eighth and last time to the form in which we know them today.

CONCLUSION

As a result of these events Keewatin has several records to its credit. It was the first Territorial District to be created in Canada. It was the only District to be created by Act of Parliament, and the first and only District to have a Lieutenant-Governor of its own. It is also the only political area to have had its boundaries changed so many times. This of course was not unforeseen

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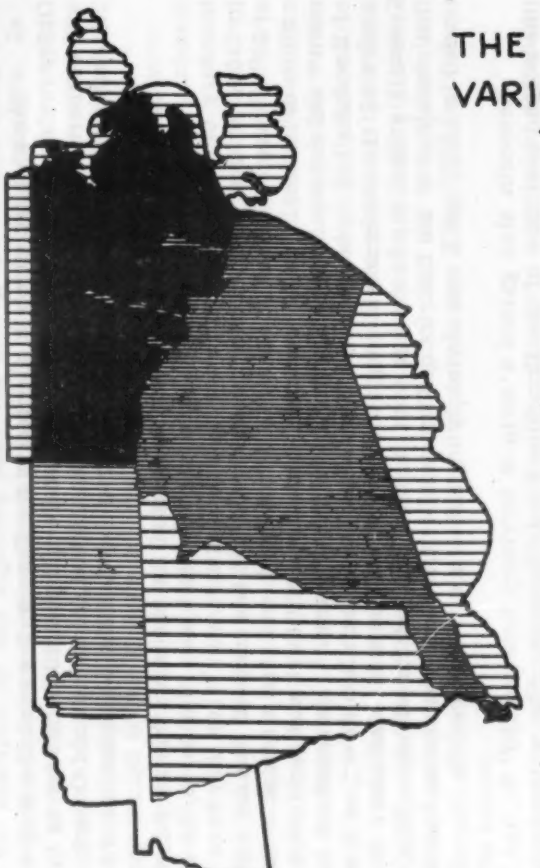
[1] Debates, House of Commons of Canada, 1905.



THE LENGTH OF TIME FOR WHICH VARIOUS AREAS WERE PART OF THE DISTRICT OF KEEWATIN

Over 75 Years

51 - 75 Years

36 - 50 Years

21 - 35 Years

11 - 20 Years

1 - 10 Years

Fig. 3

at the time of its creation in 1876. The total area of Canada which at some time or another has been part of Keewatin is thus very large. If we add all areas that are now, or have been, part of Keewatin we find that they include parts of Manitoba, Ontario, Mackenzie, Franklin and the now defunct District of Ungava. This large area includes much of the geographical centre of Canada and extends from the United States boundary to the northern continental limits of Canada. But more significantly, the areas it included at any given time were in a pioneer stage of development. When any portions developed beyond this stage, or had reasonable prospects of doing so, they were detached from Keewatin. This process, of course, is not unique to Keewatin as it occurred with all Northwest Territories as well.

But Keewatin was unique in that it covered the area where Eastern Canada and Western Canada met. Its boundary changes were thus a response to two sets of stimuli - the political expansionist tendencies of the older established provinces of Ontario and Quebec and the pressure of agricultural settlement in the prairies. The changes connected with Manitoba reflect both these stimuli. Figure 3 consolidates the various changes. It will be noted that there is a "core area" which has remained part of Keewatin from the time of its creation in 1876 to the present day. The axis of the political area of the district shortened and then swung about this core area from its original north-south position to a northwest-southeast position and hence, apart from the loss of Boothia and Melville peninsulas, the District of Keewatin has gradually become a more arctic area. Its origin lay in the problems of settlement and administration in the extreme south of central Canada but its ultimate existence is concerned with the northernmost climatic zone. North, south, east and west all met in Keewatin - the district of "the north wind" - and an examination of its boundary changes demonstrates that in a pioneer area where economic development may occur suddenly and unpredictably it is possible to have a flexible political arrangement. Or, to put it perhaps more geographically, in an area where regional boundaries meet and where, therefore, geographical changes are likely to be at a maximum, it is possible for man to arrange his political organization so as to deal with these changes in an orderly manner.

LES REGIONS GEOGRAPHIQUES ET ECONOMIQUES DE LA PROVINCE DE QUEBEC

Benoît Brouillette

l' Ecole des Hautes Etudes Commerciales de Montréal

Je ne perderai pas mon temps à discuter le concept de ce qu' on peut appeler une région géographique. J'évite, notez-le, de dire régions naturelles. Nous pourrions parler longtemps et assez inutilement, en fin de compte, de la notion théorique de région et régionalisme. Je renvoie les amateurs de définitions que j' ai publié[1] et aux quarante définitions de la région par 28 auteurs différents dans l' ouvrage d' Odum et Moore.[2]

J' ai esquissé le partage de la Province en ses régions géographiques dans Notre Milieu, et dans Canadian Régions.[3] Ce partage est plus nettement indiqué sur la carte pédagogique no. 1, PROVINCE DE QUEBEC (PHYSIQUE), que je viens de publier chez Beauchemin, Montréal, en collaboration avec Pierre Dagenais. Le partage de la Province en régions économiques paraîtra sur notre carte pédagogique no. 2, PROVINCE DE QUEBEC (ECONOMIQUE), en préparation. En comparant ces esquisses et ces cartes, on comprendra combien il est difficile de partager un pays habité en régions qui puissent satisfaire à la fois le géographe et l' économiste. Le partage est essentiellement fondé sur l' observation non seulement des traits naturels, dont la structure et le relief du pays sont les bases, mais en outre sur les facteurs humains, tels que les divisions administratives, les courants commerciaux et certaines affinités historiques et sociales.

LES REGIONS GEOGRAPHIQUES

Le partage tripartite du Québec selon ses grands traits structuraux est évident même aux yeux de l' observateur le moins averti. On voit immédiatement les trois grandes divisions du Québec méridional: le Plateau laurentien ou Bouclier canadien au Nord-ouest, les Appalaches à l' Est, la Plaine du Saint-Laurent entre les deux. Mais où tracer les limites précises de chaque division sur le terrain? Lorsqu' il existe un ressaut topographique, tel que le rebord abrupt du plateau au dessus de la vallée du Saint-Laurent, il est relativement facile d' utiliser cet accident comme limite. C' est pourquoi j' ai suivi autant que possible les courbes de niveau, entre cinq et 600 pieds, sur la rive gauche due Saint-Laurent, entre les comtés d' Argenteuil et de Charlevoix, de même

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[1] Minville, Esdras. (Ed.) Notre Milieu, Ecole H. E. C., Montréal, 1942, p. 41-51.

[2] Odum, Howard and H. E. Moore. American Regionalism, Holt, New York, 1938.

[3] Putnam, D.F., et al. Canadian Regions, Dent, Toronto, 1952.

que j'ai esquissé cette limite vers l'Ouest, le long de la rive gauche de l'Outaouais sur certaines cartes. La tâche se complique lorsque les régions de structure différente ne sont pas séparées par un ressaut topographique. Cela se trouve sur la rive droite du Saint-Laurent, entre les Appalaches et la plaine du fleuve. Il existe aux pieds des Appalaches une zone de piedmont. Dans quelle division faut-il la situer: dans les Appalaches ou dans la plaine? J'ai pris le parti de faire du piedmont une subdivision régionale, comme on le voit sur la Rive Sud de l'Estuaire, entre les Cantons de l'Est et la Gaspésie.

Ayant déterminé les trois grandes unités structurales, il me fallait délimiter des régions géographiques à l'intérieur de chacune. La Plaine du Saint-Laurent et les Appalaches se laissent facilement partager en trois parties: trois plaines, Montréal, Trois-Rivières et Québec; trois régions appalachiennes, les Cantons de l'Est, la Rive Sud de l'Estuaire, la Gaspésie. Pour les isoler, j'ai choisi des frontières de comtés aussi souvent que possible. J'ai dû cependant partager plusieurs comtés, en respectant toutefois les limites des municipalités, qui sont les plus petites unités du recensement. Par exemple, j'ai recoupé les frontières de six comtés pour séparer la plaine de Montréal des Laurentides, entre Argenteuil et Berthier; j'en ai recoupé trois autres pour séparer la même plaine des Cantons de l'Est: Missisquoi, Shefford et Bagot. J'ai fait de même pour délimiter les plaines de Trois-Rivières et de Québec. Enfin pour distinguer le Piedmont du Plateau, sur la Rive Sud de l'Estuaire, j'ai emputé sept comtés.

Afin de réduire au minimum la part d'arbitraire dans mes partages, j'ai consulté plusieurs spécialistes de divers ministères provinciaux, qui m'ont aidé dans le choix des unités administratives, grandes ou petites, qui devaient être incorporées dans telle ou telle région. Les fonctionnaires des Terres et Forêts, par exemple, m'ont incité a choisir les lignes de partage des eaux pour délimiter les régions sur le Plateau laurentien, hors des territoires habités: Laurentides, Lac Saint-Jean, Ouest du Québec. Car leurs services de protection contre l'incendie, de délimitation des coupes, etc., se fondent sur l'extension du réseau hydrographique pour déterminer l'accessibilité de chaque zone.

Le partage régional du Plateau laurentien est donc en fonction de la présence de l'homme sur ses marges ou dans ses régions isolées, ainsi que de la mise envaleur de ses richesses forestières et minières. En marge, je distingue les Laurentides, elles-mêmes subdivisées en trois: Laurentides de l'Ouest, dont la bordure est limitée au Sud par la vallée de l'Outaouais; Laurentides centrales, qui forment l'arrière-pays de Montréal et de Trois-Rivières; Laurentides de l'Est, au Nord de Québec. Depuis l'embouchure du Saguenay jusqu'au détroit de Belle-Isle, c'est la Côte Nord, dont l'arriére-pays se prolonge dans l'immense territoire du Nouveau-Québec.

L'intérieur du Plateau offre deux régions bien individualisées par l'isolement: la cuvette du Lac Saint-Jean, qui se déverse par le Saguenay, et, sur la frontière occidentale, l'Ouest du Québec, avec le Témiscamingue et l'Abitibi, auxquels j'ai, à tord, je crois, rattaché les territoires d'Abitibi et de Mistassini, sur la carte physique.

LES REGIONS ECONOMIQUES

La principale critique qu'on peut faire du partage de la Province de Québec en ses régions géographiques est qu'il n'est guère utilisable au point du vue économique. Les économistes qui partagent un pays en régions se préoccupent moins des traits physiques de ce pays que des relations commerciales, des courants de la circulation des marchandises et des personnes entre les régions et les grands centres qui les dominent. Ils fondent leurs compilations statistiques en outre sur les grandes unités du recensement, car plusieurs phénomènes les intéressant ne sont pas relevés sur la base municipale. Ils évitent donc de subdiviser un comté.

Des fonctionnaires du ministère fédéral de la Production pour la défense on esquissé un partage du Canada en ses régions économiques. J'ai repris leur projet en ce qui concerne la Province de Québec, et me suis efforcé de concilier au mieux leurs régions avec les miennes.

Ils ont partagé la Province en 10 régions, sans jamais subdiviser un comté municipal, base du recensement. Une règle aussi rigide est inappliquable par le géographe. Mais les économistes ont aussi tracé des subdivisions à l'intérieur de chacune de leurs grandes régions. C'est en utilisant ces subdivisions que nous allons trouver un terrain d'entente avec eux. Dans la carte ci-jointe j'accepte les 10 régions économiques majeures des fonctionnaires d'Ottawa, mais je leur propose des subdivisions différentes des leurs. Si nous arrivons à nous entendre sur les limites de ces dernières, nous pourrons, en les ajoutant les unes aux autres, retrouver nos régions géographiques à peu près intactes.

Examinons attentivement cette nouvelle carte en la comparant à la précédente. Les Appalaches se partagent désormais en deux au lieu de trois parties, car la Gaspésie et la Rive Sud sont réunies. Cependant le piedmont des Cantons de l'Est est moins rectiligne que sur l'autre carte, car on y respecte les frontières de comtés. Les géographes peuvent, je crois, faire cette concession. M.R. Blanchard n'avait-il pas lui-même placé Drummondville dans les Cantons. Mais je tiens à maintenir ici nos subdivisions: le Piedmont de la Rive Sud et ses Plateaux intérieurs. Je trouve aussi qu'il est bon de partager les Cantons de l'Est en deux: le Sud-Ouest, orienté vers Sherbrooke et Montréal, et le Nord-Est, orienté vers Québec. Mais le dessaccord le plus sérieux entre économistes et géographes concerne la Plaine du Saint-Laurent, dont les trois parties se confondent désormais avec les Laurentides.

Voyons quelles sont les régions majeures qu'on y trouve. Montréal, ses environs et son arrière-pays forment deux régions. Il est juste de faire une seule région économique pour la Métropole. Mais pour englober la conurbation entière dans des unités du recensement, on doit ajouter à l'Ile de Montréal, toute l'Ile Jésus et tout le comté de Chambly. On y inclut donc des parties franchement rurales, diminuant d'autant la banlieue agricole de Montréal. Malgré cet inconvénient, dont il faudrait tenir compte dans une étude locale, j'accepte ce partage comme pis-aller. La seconde région, appelée Montréal-Laurentides centrales, couvre la plaine de Montréal et les parties du Plateau laurentien dans les comtés d'Argenteuil, Labelle, Terrebonne et de leurs trois

voisins vers le Nord-Est. Ici, sans l'ombre d'un doute, les géographes reclament une distinction entre la zone de plaine et celle du Plateau. Sur la rive droite, les limites de la plaine s'inscrivent naturellement jusqu'à celles des Cantons de l'Est, sauf Chambly rattaché à la Métropole. A cause du nouveau rayonnement de Sorel, j'accepte en outre de rattacher le comté d'Yamaska à Montréal plutôt qu'à Trois-Rivières. Sur la rive gauche du Saint-Laurent, les limites N.-O. de la plaine doivent nécessairement recouper les comtés qui s'étendent au-delà sur le plateau. La meilleure solution est celle proposée dans la carte des régions géographiques. Même chose pour la région de Trois-Rivières: une plaine au bord de l'eau, un plateau en Mauricie, séparés par la limite indiquée sur notre carte précédente.

La région de Québec peut se subdiviser en trois parties: une conurbation, correspondant à la région métropolitaine de Québec selon le recensement, la plaine de Québec sur les deux rives et dans l'Ile d'Orléans; les Laurentides de l'Est entre Portneuf et Charlevoix, avec notre limite physique entre ces deux dernières. Notons ici que les forestiers vont peut-être trouver à redire; car pour satisfaire aux besoins des économistes, je pense qu'il faut reculer la limite nord de la région jusqu'aux frontières descomtés.

La région de Hull-Laurentides de l'Ouest s'inscrit bien dans les limites des comtés de Papineau, Hull, Gatineau et Pontiac. Mais je profite de l'occasion pour corriger une lacune de ma carte précédente, en distinguant une zone méridionale de plaine sur la rive de l'Outaouais. Sur cette lisière s'exerce les trois-quarts de l'activité de la région.

La région du Saguenay-Lac Saint-Jean se voit désormais limitée par la vaste étendue des comtés municipaux et des territoires qui en dépendent économiquement. Mais il importe d'y distinguer trois subdivisions: celle du comté de Chicoutimi, où la fonction industrielle prédomine, celle du comtés jumaux du Lac Saint-Jean, où l'agriculture occupe une place honorable auprès des industries, enfin celle desterritoires d'Abitibi et de Mistassini, qui sont rattachés à la région par les seules voies de transport vers ces lieux éloignés (route et ligne d'avion).

La Côte Nord comprend le reste de la partie habitée du Québec vers l'Est, et donne accès au pays minier du Nouveau-Québec. Trois subdivisions s'imposent: l'Ouest, entre Tadoussac et Clark City, où domine l'exploitation forestière, l'Est, de Sept-Iles à Blanc Sablon, région de pêche, de chasse, de forêts peu exploitées sauf en Anticosti, enfin le Grand Nord, accessible par avion et bientôt par rail de Sept-Iles.

Reste l'Ouest du Québec, où les divisions du recensement fédéral ne sont pas satisfaisantes. Il vaut mieux le partager selon les comtés provinciaux, et y distinguer l'Abitibi-Est avec Val d'Or et Amos du reste où domine l'influence de Rouyn et du Témiscamingue.

On discutera encore longuement sur les détails de ces régions tant géographiques qu'économiques. Mais je crois que dans les circonstances, elles peuvent servir de base à la recherche régionale, du moins plus fructueusement que le partage du territoire en comtés, imposé par les arpenteurs des seigneuries et des cantons.

THE GEOGRAPHY OF RADIO IN CANADA[1]

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University of Western Ontario

Radio broadcasting lends itself to study by geographers because of its space covering characteristics. The present study indicates that one of the principal factors which keeps down the number of radio stations is that the area covered by one radio station cannot overlap the area covered by another radio station when both are using the same frequency. In North America there are 107 frequencies for radio broadcasting. (Actually each 'frequency' is a bank of frequencies or a channel.) This is the extreme theoretical number of stations which a receiving set could pick up. In practice, the number of stations which can be listened to comfortably is much less than this. Every location is a fringe location for at least some stations, and powerful stations nearby always take up more room on the dial than they should. The number of programs which can be heard is further limited because many stations which can be heard belong to the same network and carry the same program. The net result is that there is less radio broadcasting per capita in densely populated areas where the available channels are completely filled up and there is no room for any more stations.

A short technical note is now necessary in order to make clear the geographic nature of radio. If a radio station is to broadcast the human voice or music it must use many frequencies, ranging from low frequencies for low notes and deep voices to higher frequencies for high notes. In practice more than half the audible frequencies are not transmitted by radio. This saves space in the electromagnetic spectrum and thus makes room for more stations. Enough frequencies are broadcast to make words and music recognizable. The electromagnetic spectrum is made up of wave lengths of many different sizes including light waves, X-rays, radar size waves, waves used for television, diathermy and so on. The number of frequencies available for radio broadcasting is thus limited. The problem of broadcasters is to use the space available as efficiently as possible. A 50,000 watt station will make it impossible for any other radio station within 1,000 miles to use the same frequency. A 250 watt radio station, on the other hand, covers such a small area that another small radio station can use the same frequency only 100 miles away. In densely populated parts of Canada the radio stations are so close together than many towns must do without any station and often large cities must be content with low power stations. In western Canada, the crowding is less severe and people can have as many radio stations as they can pay for. In northern Canada the population is so sparse that they cannot afford to support any ordinary broadcasting stations.

THE GENERAL DISTRIBUTION OF CANADIAN RADIO STATIONS

The map (Fig. 1) showing the radio stations of Canada helps to point out some of the characteristics of radio which have been mentioned. In southern

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[1] This paper considers radio between 540 kc. and 1,600 kc. only.

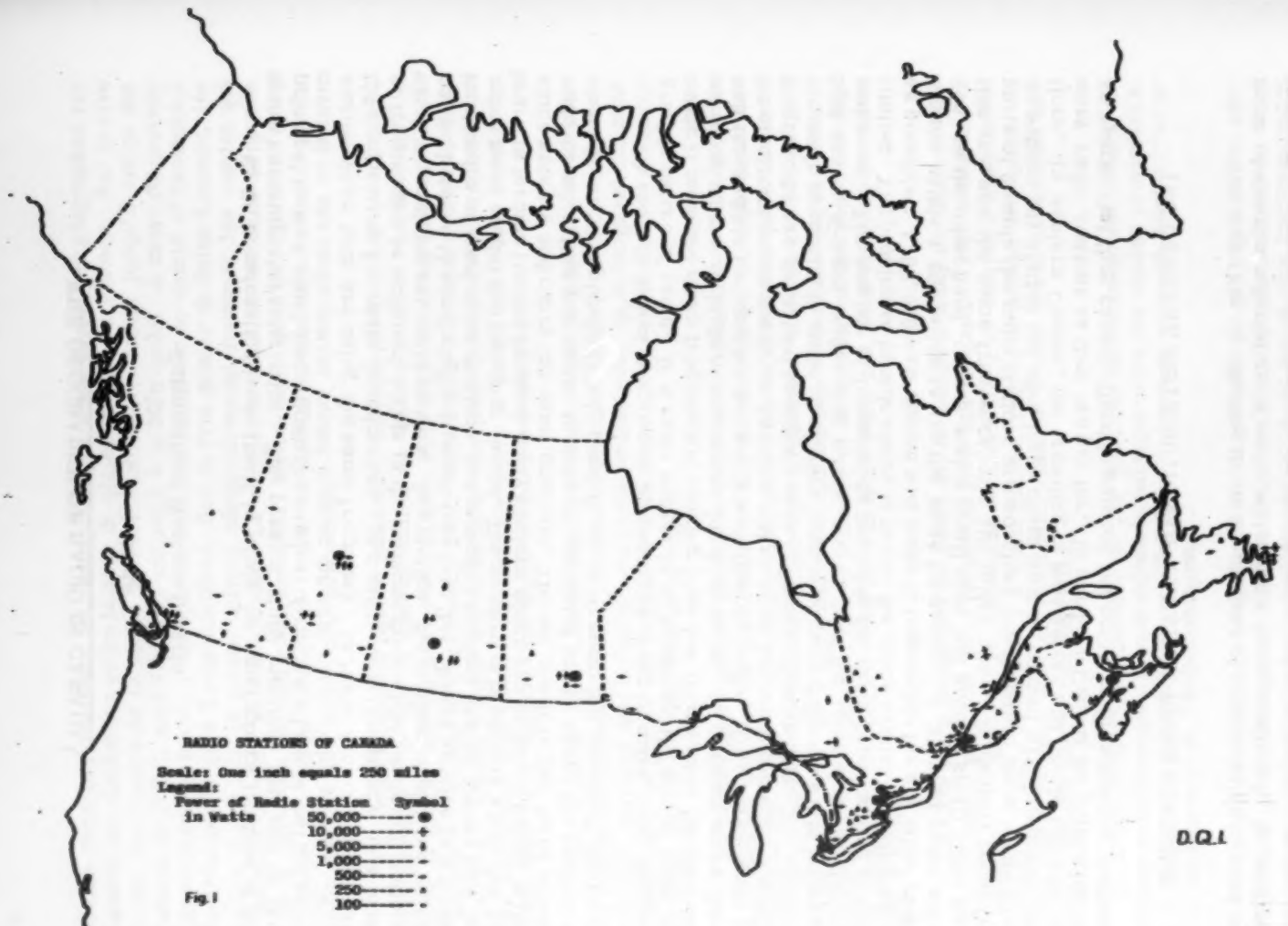
RADIO STATIONS OF CANADA
Scale: One inch equals 250 miles
Legend:
Power of Radio Station in Watts
Symbol
50,000
10,000
5,000
1,000
500
250
100
D.Q.I

Fig. I

Ontario and Quebec the radio stations are closer together than they are in the Maritimes and in the west, but the increased density is not nearly proportional to the density of the population. The map also shows that the radio stations in southern Ontario and Quebec tend to be smaller than those in the north, east and west of Canada. For instance, Corner Brook, Timmins, Flin Flon and Dawson Creek have fairly powerful radio stations while much larger towns such as Welland, Galt, Lévis and St. Hyacinthe have no radio stations at all. A more exact statement of the situation can only be made by the use of statistics. The map shows, in a vague way, that the Maritimes and Manitoba have fewer radio stations than the far western provinces, but this can be shown more clearly on a graph.

A very important factor affecting Canadian radio is the proximity of the United States. The richest and most densely settled parts of the United States are right across the border from Canada's most densely settled area and this hinders the development of radio in both countries. Of the 107 channels which are used in North America, Canada has no stations at all on 44 channels and the United States has no stations on one channel. Most of the channels on which Canada has no station are occupied by 50,000 watt stations in the United States. Most of these stations cannot be easily picked up in Canada, certainly not all over Canada, but another station on the same frequency would, presumably, interfere with the first.

If radio programs are considered to be a good thing, then Canada is unfortunate in having almost its entire population situated quite near the American border. All of Canada's radio stations must take into consideration the nearby American stations, while in the United States many stations can operate in the south without interfering in the least with Canadian stations on the same frequency. In western Canada the fact that Canadians live close to the border is less important as the western United States is not densely populated.

THE DISTRIBUTION OF RADIO STATIONS ACCORDING TO THE POPULATION PER RADIO STATION

The first set of graphs (Fig. 2) shows the population per radio station for the different provinces of Canada. The first graph[1] shows the population per radio station when all radio stations are considered. It will be noted that Quebec has the most people per radio station and that Ontario, Manitoba and Saskatchewan come next. Alberta, British Columbia, and the Maritimes have much less population per radio station. Newfoundland has almost three times as many radio stations per capita as Quebec. The situation in Manitoba and Saskatchewan is somewhat puzzling since they are in the less densely settled

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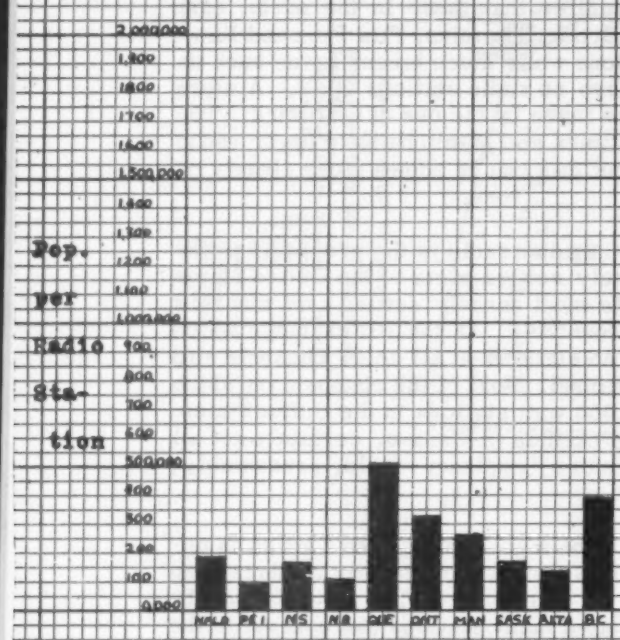
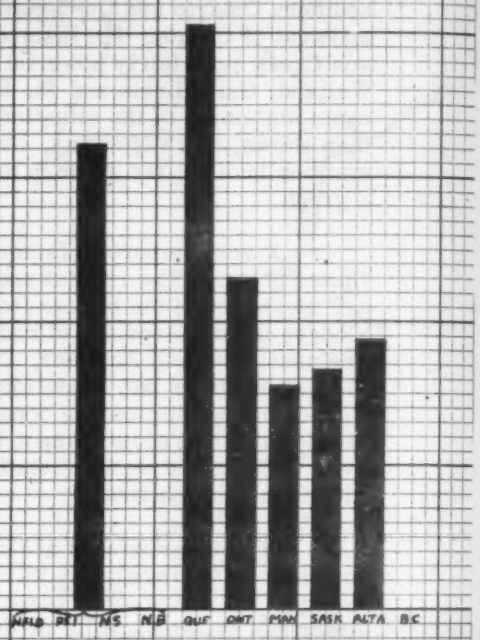
[1] The following cities have radio stations in addition to those shown on the graphs: Victoria, B.C., one 1,000 and one 250 watt; Sudbury, Ont., one 5,000 and one 1,000 watt; Sherbrooke, Que., one 1,000 and one 250 watt; La Sarre, Que., (2,744) one 250 watt; Ville Marie, Que., one 1,000 watt; Sydney, N.S., one 5,000 and one 1,000 watt; Chicoutimi, Que., one 10,000 watt; St. John's, Nfld., (53,000) one 10,000 watt, one 5,000 watt, one 1,000 watt, one 500 watt and one 100 watt.

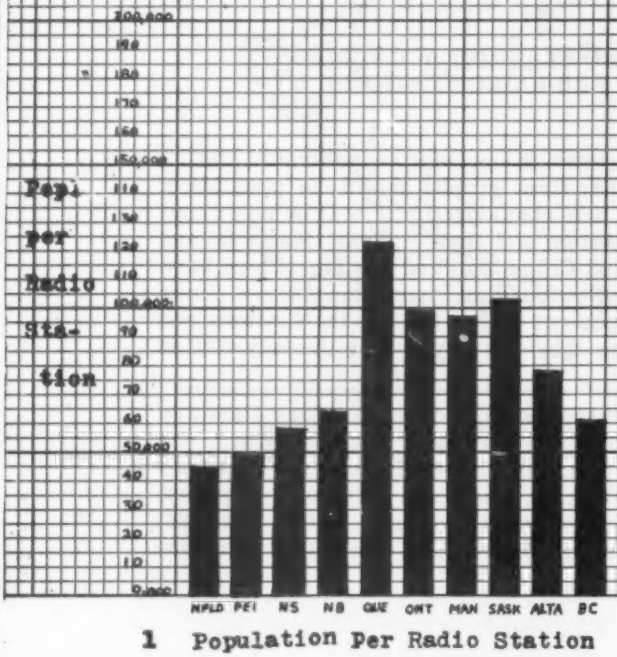
Fig. 2



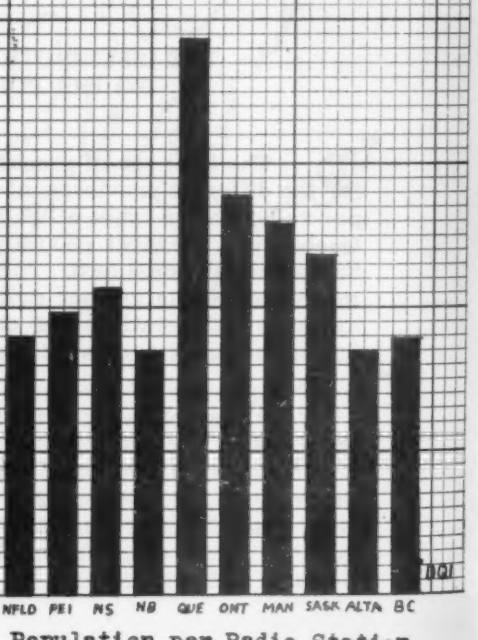
3 Population per Radio Station of 5000 watts and over.



4 Population per 50,000 watt Radio Station.



1 Population Per Radio Station



2 Population per Radio Station over 250 watts

west, and should be able to have more radio stations per capita than Ontario. Part of the explanation may be that they are quite near the American middle west; another factor is that they seem to have a few moderately large stations instead of more small ones.

In the second graph the 250 watt stations have been left out, and Manitoba and Saskatchewan appear more as one would expect them to. Quebec is still worst off, as it is in all these graphs, and Ontario comes next. Quebec is the worst off probably because it is closest to the extremely dense radio area around New York City. The eastern seaboard of the United States seems to have as many radio stations as it can, and they are as high powered as possible, so that as a result, nearby areas in the United States and Canada are blighted. The Maritimes and Ontario also show the effect of this powerful neighbour. This is shown most clearly in the graph dealing with the 50, 000 watt stations.

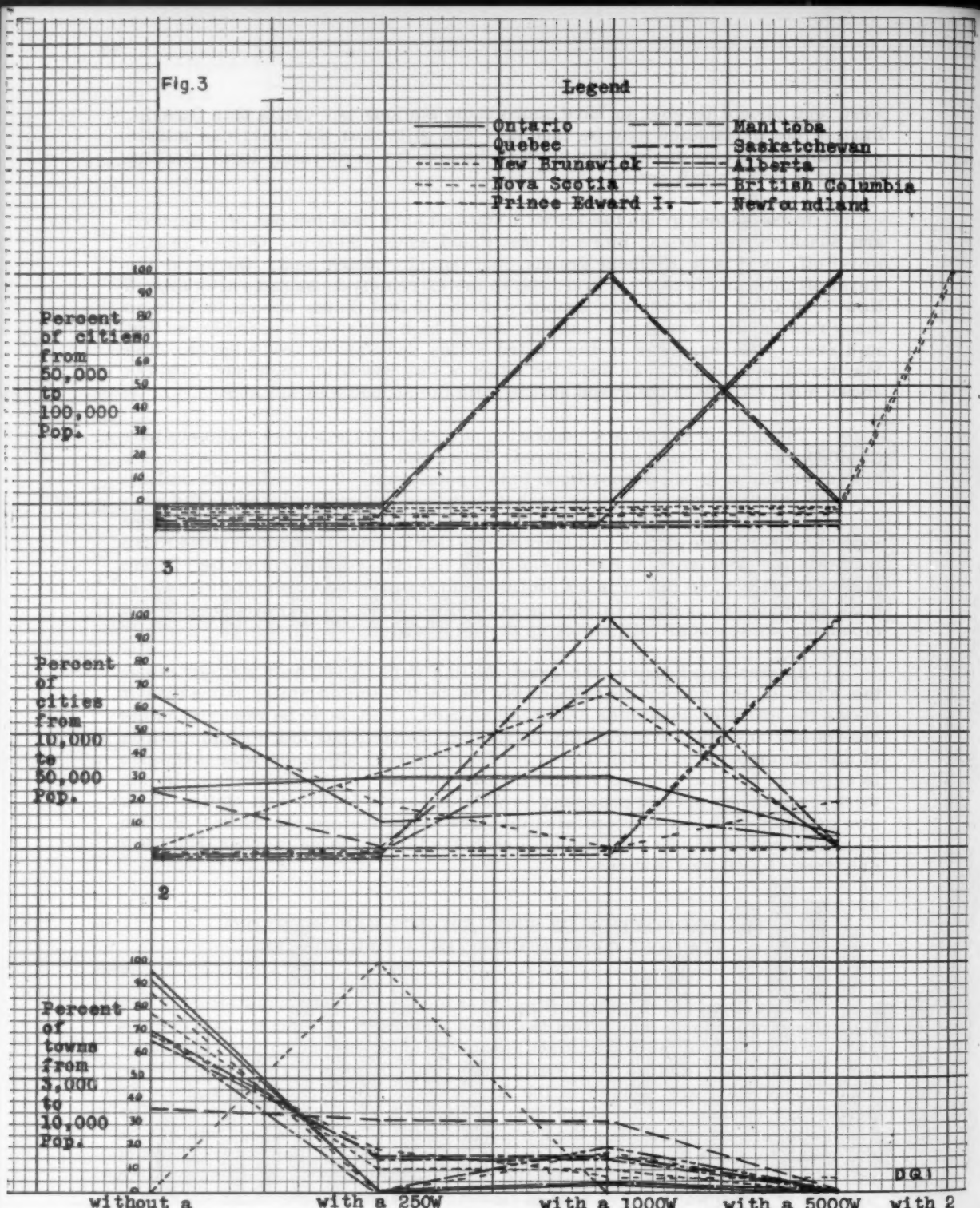
The third graph shows population per radio station when radio stations of 5,000 watts and over are considered. This graph again shows that the number of radio stations is not proportional to the population. Central Canada suffers because radio stations cannot be packed together any more closely. The surprising feature of this graph is the situation in British Columbia. The large population per radio station of high power in this province is probably due to the fact that the population of British Columbia is scattered discontinuously in the mountain valleys, so that it is not profitable to operate large radio stations when most of the power is spent in serving uninhabited areas. It may also be that the mountains make it difficult to pick up distant stations.

As mentioned above, the graph dealing with 50, 000 watt stations shows the effect of the nearby population centres in the United States more than it shows the effect of population density in Canada. This is to be expected in the case of stations which cover a very large area. Ontario has more radio stations of this power per capita than Quebec or the Maritimes although southern Ontario is certainly far more densely settled than any part of the Maritimes. In the west, each of the prairie provinces is able to have a 50, 000 watt station of its own and thus each has more service than any of the eastern provinces. British Columbia has no 50,000 watt station - probably for the same reasons that it has only three 5, 000 watt stations.

THE PROPORTION OF SETTLEMENTS HAVING RADIO STATIONS OF VARIOUS SIZES, BY PROVINCES

The second set of graphs (Fig. 3) is designed to show the effect of the limitations of radio as they affect the cities and towns of Canada. All municipalities in Canada of more than 3,000 population have been taken into consideration and have been divided into four groups. Small communities from 3,000 to 10,000 population are studied in the first graph. The vertical scale gives the percentage of these towns which have radio stations of different sizes. The radio stations are depicted on the horizontal scale. There is a separate line on the graph for each province. In Ontario, for example, 97 per cent of towns of this size have no radio stations, and the remaining three per cent all have radio stations of 1, 000 watts. No towns of this size in Ontario have radio stations of

Fig.3


Legend
Ontario
Quebec
New Brunswick
Nova Scotia
Prince Edward I.
Manitoba
Saskatchewan
Alberta
British Columbia
Newfoundland
Percent of cities from 50,000 to 100,000 Pop.
3
Percent of cities from 10,000 to 50,000 Pop.
2
Percent of towns from 3,000 to 10,000 Pop.
DG1
without a radio station
1
with a 250W station only
with a 1000W station only
with a 5000W station only
with 2 5000W stations

250 watts or of 5,000 watts. It is interesting to note that this three per cent of the towns consists of Kenora and Fort Frances, both in the north. One other exception should be noted - Wingham has a 1,000 watt station and has less than 3,000 people. Such a station in such a small town can be thought of mainly as a regional station, not concerned mainly with Wingham. The map shows that the Wingham station too is somewhat isolated from other stations.

The first graph shows two patterns clearly and allows several other deductions to be made about the forces which determine the location of radio stations. Ontario and Quebec, the densely populated provinces, have very similar patterns and this pattern is different from that of all other provinces. In both cases more than 90 per cent of towns of this size have no radio stations, and conversely almost no towns, in these provinces, have radio stations of 250, 1,000 or 5,000 watts. Manitoba and Alberta have very similar patterns but this pattern is different from that of the central provinces. Seventy per cent of towns in Manitoba and Alberta between 3,000 and 10,000 population have no radio station, but 15 per cent have 250 watt stations and another 15 per cent have 1,000 watt stations. It can be concluded that space limitations for radio stations are not so severe in the prairies as in central Canada. This conclusion is borne out by Saskatchewan, in which almost 30 per cent of the towns have 1,000 watt stations. British Columbia is farthest from the densely settled part of North America and has most radio stations. Only 37 per cent of its towns have no radio stations, 32 per cent have 250 watt stations and 31 per cent have 1,000 watt stations. The Maritimes are near the dense core of population, but are not densely populated themselves, so that as one would expect, their pattern falls in between the patterns of the central and the western provinces. In New Brunswick and Newfoundland about 80 per cent of towns of this size have no radio, while 70 per cent are without stations in Nova Scotia. Considering these provinces together, 250 watt stations and 1,000 watt stations are found in equal numbers among the remaining towns. Prince Edward Island has 250 watt stations in all her towns of this size. This favourable state of affairs is most likely due to the provincial importance of the single town involved. There are other examples of this sort of political influence.

The second graph shows the relative numbers and sizes of radio stations in towns from 10,000 to 50,000 population, and again Ontario and Quebec tend to be worst off. In Quebec, 67 per cent of these cities have no radio stations while in Ontario this is true of only 26 per cent of these cities. Apart from Nova Scotia and British Columbia, no other province has any city of this size without a radio station. In Ontario, over 60 per cent have either a 250 watt or a thousand watt station, while in Quebec the figures are respectively 12 and 15 per cent of the cities. The high percentage of cities with no radio in Nova Scotia is not too surprising considering the nearness of the American eastern seaboard cities, but the figure of 25 per cent for British Columbia is unexpected. The city concerned is North Vancouver, which is sort of a suburb of Vancouver. Suburbs are always in an unusually difficult position as they are blighted by the great radio power of the central city. Most, but by no means all, of the cities in Ontario and Quebec which have no radio are of the suburb type.

If cities with 1,000 watt stations are examined it will be found that all cities in Manitoba, of the size being considered here, have stations of this power, along with 75 per cent of these cities in British Columbia, 67 per cent in

New Brunswick and 50 per cent in Alberta. In the case of 5,000 watt stations, 100 per cent of these cities in Prince Edward Island and Saskatchewan have them, 50 per cent in Alberta and 20 per cent in Nova Scotia. All these figures are much higher than the figures for Ontario and Quebec. Newfoundland has no cities in this size range.

The last graph is more unsatisfactory because so few cities are involved. The graph shows however that no city between 50 and 100,000 population is without a radio station and that all these cities have radio stations larger than 250 watts. In Quebec and British Columbia all cities of this size have stations of 5,000 watts, while in Nova Scotia and New Brunswick all such cities have two 5,000 watt stations. If this graph shows anything, it shows that Ontario and Quebec are not the most favoured provinces.

For cities of more than 100,000 population the situation becomes more complicated, both because the cities vary greatly in size and because they have more than one radio station each. Furthermore the radio stations are of different powers. To begin in the west, Vancouver with 345,000 people has four radio stations - three of 5,000 watts and one 1,000 watt station. Calgary (129,000) has stations of five, 10 and 1,000 watts: Edmonton (160,000) has one 1,000, three 5,000 and one 50,000 watt station. It is interesting to compare Edmonton with Hamilton, Ontario (208,000) which has only two 5,000 watt stations. The explanation is the Edmonton is not surrounded by other cities and towns. While there are no cities of 100,000 population in Saskatchewan, Regina (71,000) has one 5,000 watt station - which is still ahead of Hamilton - while Saskatoon (53,000) has one 5,000 and one 250 watt station. The biggest station in Saskatchewan has not yet been mentioned. It is the 50,000 watt station at Watrous (1,228). It is unlikely that there is much local Watrous news on this station! In Manitoba, Winnipeg (236,000) has one 50,000, two 5,000, and one 250 watt station.

There are four cities in Ontario with more than 100,000 people and London will soon make a fifth. Hamilton has already been mentioned. Ottawa (202,000) has two 1,000 and one 5,000 watt station. Windsor has a 10,000 watt station and a 50,000 watt station. Toronto (676,000) has three 50,000 watt stations, two 1,000 watt and one 250 watt station. As "Rawhide" has remarked, Toronto contains 'the great throbbing pulse of Canadian radio'!

In the province of Quebec, Quebec City (164,000) stations include one of 5,000, two of 1,000 and one of 250 watts. Montreal (1,021,000) has two 50,000 watt stations, one 10,000 watt station, two of 5,000 watts and one 1,000 watt station. This is not very many stations, especially when the fact that broadcasts are given in two languages is considered. Throughout this study Quebec always seems to have the least radio service of any of the provinces.

In the Maritimes there are no cities of this size but there is a 50,000 watt station at Sackville, N.B., (2,873) which must be mentioned. Like the station at Watrous, Sask., it is a regional station. It broadcasts to and for all the Maritime provinces.

CONCLUSION

The space-filling nature of radio is such that densely populated areas like Quebec and Ontario receive far less radio service per capita and per city, than less densely populated western provinces. The maritime provinces seem to be between the two extremes as far as radio service is concerned.

When the social effects of radio are taken into consideration the radio stations in central Canada definitely have larger audiences. Radio at its best tends to have a centralizing and demagogic effect. Many people can be harangued by one person, can be influenced by the same type of news and commentary and can hear the same standardized music. There is a good deal of evidence to show that radio tends to deal with least common denominators of intelligence, so as to reach the largest possible audience. The purpose of this paper has been to show that in densely populated areas radio is not at its best, and that due to its nature, radio broadcasting cannot be much different from the radio broadcasting which exists at present.

THE CANADIAN ASSOCIATION OF GEOGRAPHERS

PROCEEDINGS OF THE THIRD ANNUAL MEETING

The Third Annual Meeting of the Canadian Association of Geographers was held in London, at the University of Western Ontario, from May 28th to 31st, 1953.

The formal meetings came to order with a welcoming address from Dr. G.E. Hall, President of the University of Western Ontario. The President of the Association, the Chairmen of the various committees, the Secretary and the Treasurer then presented their reports. These reports have already been published in detail and the main items are repeated below for the record. The papers presented after the business meeting occupy the preceding pages of this volume.

Geographers and a Council of Arts and Sciences

The President reported that he had been in touch with the Prime Minister's Office regarding the Report of the Royal Commission on National Development in the Arts, Letters and Sciences. He had received a reply to the effect that if a Council of Arts and Sciences is created the Association would be consulted.

The Canadian Committee of the International Geographical Union

The President reported that he had made a formal request, through the Department of Mines and Technical Surveys, for the revival of the Canadian Committee of the International Geographical Union. This had been done and Dr. B. Brouillette appointed its temporary chairman.

Geography in the Royal Canadian Military Colleges

In reply to correspondence from the Association regarding the teaching of geography at the Royal Canadian Military Colleges, the Deputy Minister of the Department of National Defence had stated that geography was taught in these colleges but it was not offered as a regular course. In future however, it was planned that geography should become part of the regular curriculum.

The Centenary Celebrations of St. Francis-Xavier University

St. Francis-Xavier University invited the Association to send a representative to its Centenary Celebrations in Antigonish, Nova Scotia. The Executive Committee later appointed Dr. Trevor Lloyd as their delegate.

The Coronation Medal

The Under-Secretary of State advised the Association that it was among the national organizations recommended for the award of a Coronation Medal. Dr. D.F. Putnam, first President of the Association, was elected by the Association as the person to receive this honour.

Committees

The new Executive Committee was elected as follows:

Honorary Presidents:	Griffith Taylor; Raoul Blanchard.
President:	J. Ross Mackay.
First Vice-President:	B. Brouillette.
Second Vice-President:	J.W. Watson.
Secretary:	P. Camu.
Treasurer:	J.K. Fraser.
Councillors:	T. Lloyd.
	E.G. Pleva.
	G. Tatham.
	W.C. Wonders.
	B. Zaborski.

The Executive Committee later appointed members to the various Committees as follows: (The first name is that of the Chairman.)

Awards Committee:	T. Lloyd; J.K. Fraser.
Convention Committee:	According to locality (in 1953, E.G. Pleva)
Education Policy Committee:	E.G. Pleva; G. Aumont; J.L. Robinson; N.V. Scarfe.
Membership Committee:	W.C. Wonders; J.W. Watson.
Nomination Committee:	P. Dagenais, with power to add.
Programme Committee:	J.B. Bird; B. Brouillette.
Project Committee:	B. Zaborski; H.A. Wood.
Publications Committee:	N.L. Nicholson, Editor; P.Dagenais.

How the Geographer Serves the Community

On May 30th, the last day of the annual meeting, a field trip was organized with the theme "How the geographer serves the community". The group left the University of Western Ontario at 9:00 a.m. Fanshawe Dam was the first exhibit. The lake behind the dam is designed to be used for flood control and recreation; for these purposes the valley authority has wisely purchased a large tract of land surrounding the lake. The industries and surburban housing development near London were pointed out and there was a good deal of discussion about the channel straightening on the south branch of the Thames near Ingersoll. One argument was that the artificial channel is too small to hold the water that formerly covered the whole valley floor in flood time; the opposition maintained that the straight channel would allow the water to flow away more quickly than formerly and flooding would thus be avoided. The morainic country south of Ingersoll is occupied by dairy farms and south of that is the flat sandy

tobacco country. Port Burwell offered several features of interest - the coal docks, a church built at the time of the first settlement, and wave erosion of the cliffs along the lake. At Port Bruce, the Rocabore Inn, and the tributary valleys of Catfish Creek which have been decapitated by lake shore erosion,were pointed out. A gully in which active erosion is taking place was examined and, finally, at Port Stanley, lunch was served on the edge of a former plain. After lunch the summer shack area of Port Stanley known as the 'jungle' was viewed and the bus then returned to the University by way of St. Thomas and Lambeth.